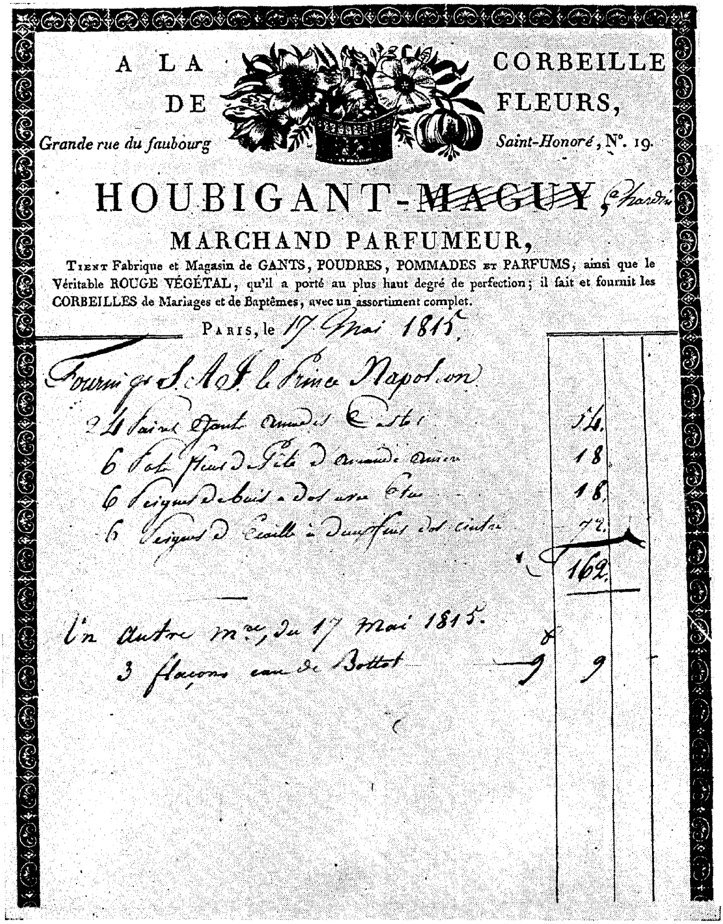
A LA CORBEILLE DE FLEURS,

Grande rue du faubourg Saint-Honoré, N°. 19.

HOUBIGANT-~~MAGUY~~ Chardin

MARCHAND PARFUMEUR,

TIENT Fabrique et Magasin de GANTS, POUDRES, POMMADES ET PARFUMS; ainsi que le Véritable ROUGE VÉGÉTAL, qu'il a porté au plus haut degré de perfection; il fait et fournit les CORBEILLES de Mariages et de Baptêmes, avec un assortiment complet.

PARIS, le 17 Mai 1815.

Fourni à S. A. I. le Prince Napoléon

24 paires Gants ...	54
6 Pots Fleur de Pâte d'amande ...	18
6 Peignes de buis ...	18
6 Peignes d'Écaille ...	72
	162

Un autre m.re, du 17 mai 1815.

3 flacons eau de Bottot	9

Only a month before his defeat at Waterloo, Napoleon was ordering perfumed gloves and other toiletries from his Parisian supplier. (Courtesy of Houbigant Company.)

(Frontispiece)

The Science and Art of PERFUMERY

BY

EDWARD SAGARIN
Givaudan-Delawanna, Inc.

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THE SCIENCE AND ART OF PERFUMERY

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To

DAVID

Schenectady, *January* 30, 1911
Palawan, *June* 12, 1945

Foreword

THE story of odors is an outline of science and an excursion into the realm of aesthetics. It leads us to fields seldom associated with the fragrant vapors arising from a tiny bottle.

It is the story of chemistry, of molecules so small they would be invisible under the most powerful electron microscope were they magnified a millionfold. It is the story of painstaking chemical analysis by the probers of molecular structure, and of ingenious synthesis by organic chemists the world over. And yet odor defies chemical explanation and scientific classification and eludes all efforts to correlate it with other chemical and physical properties in the form of a mathematical equation.

This is a science of botany, of plants with invaluable essential oils, of their purpose and development in the plant, and of the centuries of efforts on the part of men of science and industry to capture these oils for their own purposes. It is the story of the processes that science and art have developed for obtaining these natural perfumes.

The scope of perfumery is a broad one. It leads to problems of anthropology and evolution, mythology and religion, physiology and medical therapy. It has a history as old as the first Egyptian hieroglyphics and the ancient Chinese civilization, and a geography of lands as varied and as fascinating as ever adorned a philatelist's catalogue.

FOREWORD

Odor is the story of language, of man's efforts to find words to express emotion and sensation. It is allied with all the senses, indissolubly with taste, with color, sound, and memory, and deeply affected by the psychological phenomenon, the power of suggestion.

Perfumery is the theme of all the world's poetry. It has been the inspiration to the most articulate and the most sensitive.

This is the story of industries which are seemingly far removed from the dram of perfume but which must be conscious of the odor of their products; they are industries whose commodities are valued at tens of billions of dollars, and with which we come in contact each moment of the day.

Odor is all this, and more. All human knowledge, philosophers have often said, is interrelated. In the study of odor we have an outstanding example of a meeting ground of chemistry, botany, aesthetics, psychology, linguistics, history, and other fields of study.

It is a view of one cross section of man's knowledge, as related to odors and perfumes, that is depicted in this volume.

"All knowledge is one," wrote the German philosopher Hegel. "If one were to know everything about any one thing, he would know all."

EDWARD SAGARIN.

NEW YORK, N. Y.,
October, 1945.

Acknowledgments

THIS book is the result of the efforts of all of the author's colleagues at Givaudan-Delawanna, Inc. Every member of the staff has been patient in answering questions, seeking out literature, in reading, discussing, and advising. The author wishes to thank all of them collectively.

In addition, he wishes to express his appreciation to several members of the staff who have reviewed the manuscript in full or in part and have given many valuable suggestions. They are Dr. Max Luthy, Mr. R. M. Stevenson, and Mr. A. T. Fiore, who have read the book in its entirety, and whose criticisms have been of the greatest value; also Mr. Georges Reboul, who helped in preparing the section dealing with the methods of production of essential oils and flower oils; Mr. Joseph Balsam and Mr. Paul Sandars, who helped in many sections dealing with the art of the perfumer; Dr. William Gump, Dr. M. S. Carpenter, and Dr. Otto Schwarzkopf, who aided in preparing several technical chapters, and Mr. Svend E. Andersen, who helped in the chapter dealing with flavors.

I am particularly grateful to Dr. Eric C. Kunz, who has encouraged my studies of this subject for many years, and who has made such a remarkable contribution to the development of an American aromatic chemical industry, and to Dr. Marston T. Bogert, professor emeritus of organic chemistry at Columbia University and foremost authority on perfumery among America's chemical educa-

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In the preparation of the material on the use of animal products in perfumery the author has been aided by Dr. P. G. Stevens of Yale University and Dr. J. L. E. Erickson of Louisiana State University, foremost authorities and workers in this field.

Sincere thanks are also due to Mr. Jean Retaillau of Jean Niel, Inc., and Mr. Henri Robert of Henri Robert, Inc., both of whom have wide experience in the French floral-oil industry.

The author wishes to thank Mr. Carl Jensen of Ungerer & Co., Inc., who aided in the preparation of the chapter on flavors and odors.

Several chapters, or sections of chapters, of this book have appeared in the trade press. They are used here with the kind permission of the journals in which they were originally published: *The American Perfumer and Essential Oil Review*, *Drug and Cosmetic Industry*, and *Soap and Sanitary Chemicals*.

Finally, the author wishes to express appreciation to all those who have cooperated in collecting the photographs for this book. He has seen his friends in the industry dig deep into dusty files for forgotten pictures; he has watched them take heavy frames off the walls of their showrooms; he has seen them readily consent to lending irreplaceable documents from their private archives. The little courtesy lines will identify the donors. It is hoped that this extra word will convey the author's personal feelings of gratitude.

EDWARD SAGARIN.

Contents

CHAPTER 1

Forty Centuries of Fragrance

Cleopatra's nose: Had it been shorter, the whole aspect of the world would have been altered.

PASCAL

IN the sumptuous tomb that had been built for him by Egyptian workers and slaves, the body of the youthful Pharaoh, King Tutankhamen, lay mummified for more than three thousand years. And when the tomb was opened, the containers that once had held perfumes buried with other treasures in the underground chambers still gave forth a fragrance.

It was the fourth of November, in the year 1922, and a party of British scientists were making history in the majestic shadows of the Sphinx and the Pyramids. Excitement ran high among the archaeologists who opened the door leading to a descending stairway for which they had been searching.

In the months that followed, as they examined the treasures of the tomb, the scientists discovered in the cavern ancient Egyptian receptacles for fragrant perfumes and ointments. The materials had evaporated through the ages, but the containers still held the aroma of the substances buried with the king many centuries before.

In the tomb of King Tut were found the oldest *flacons* for perfumes to survive to modern times, but the creations of the Egyptian apothecaries were not the first man-made odors.

Perfumery traces its origins to the beginnings of civilization. The initial perfumes were offerings to the gods, made by heathen priests. When the priests became the doctors as well, they continued to use perfumes as healing oils.

In almost every land odorous incense was presented by worshippers in their temples. The substances that had a magical power of pleasing one or many of the almighties were valued as curatives and then developed among various early civilizations as a medium of exchange and a beautifier to make the body more alluring.

The earliest Chinese records tell of the use of incense among the Orientals. The Chinese mandarins used a perfume on their robes, the name of which, *e hiang*, has survived to this day. Their taste ran to the strong and, by our present-day standards, even to the obnoxious. Their great contribution was the discovery of musk, which became renowned throughout the ancient Chinese empires.

The Chinese, in a custom that was later to be found in every citadel of western European culture, burned incense at funerals and, while they marched in burial processions, burned odorous matches.

The Hindus, too, began to burn incense for their gods at the dawn of Asiatic civilization. Their odorous offerings to the deities were made of woods and grasses and included

materials used in modern perfumery, the gingergrass and the vetivert.

The culture of the Far East went into an eclipse and left only a relatively vague imprint on our modern civilization. Most interesting in the use of perfumes by these peoples was their discovery of materials that were destined to become important in the art, as well as the parallels found in the origins and development of the science in various lands and ages.

The science of odors, as it has come down to us, is traceable to the world of the Egyptians, the Israelites, the Carthaginians, and the Arabs, the peoples inhabiting the African side of the Mediterranean and the valleys of the Tigris and the Euphrates.

In the land of the Nile perfumes were associated with immortality. The invisible gods were given their offerings, and the dead Pharaohs, who were to be mummified until ready for reincarnation, were buried with perfumes on their bodies. Valuable odorous materials were placed in their tombs, not only to please the senses that would perceive these substances through their sarcophagi, but to make the reign of the dead one more pleasant in the chamber where he would rule supreme.

The priests went to the temples with their aromatic gifts thrice daily and each time gave a different type of incense. Their formulas were compounded of natural resins and gums, made from woods and plants.

Not for long was the use of perfumes confined to religious symbolism and funereal processions. The princesses found

these substances added enchantment to their bodies. Fragrance added charm. Among the nobility the first fashions in perfumes were found, and the practice of using redolent substances soon spread to the commoners.

Indulgence followed close upon the discovery of perfumes for adornment. The demand for these materials heightened. They were prominent in the beginnings of commerce with foreign lands. From Arabia, traders came with camels laden with myrrh and frankincense.

Egyptian savants began to devise ingenious apparatus for making perfumes. They discovered that citrus-fruit peels could be pressed until odorous oils oozed out, and so arose the process now known as "expression." Their hieroglyphics display crude distilling apparatus. In the main, they relied on the gums that could be obtained by tapping trees.

Oldest of all surviving perfume trade-marks is the ancient Egyptian name of Kyphi. Kyphi was the most sacred of all the religious fragrances. Each night it was offered by the priests in their temples.

For Cleopatra, living in the first century before Christ, Kyphi was not confined to the gods. Not a beautiful woman, she developed the art of self-adornment into a science. She saw in perfumes one more means of embellishing her body, aiding her in beguiling her Roman admirers, Caesar and Antony. She was the first of the high priestesses of an era of cosmetics.

From its early association with incense, perfume soon became wedded to cosmetics. Paints, powders, rouges, and eyebrow pencils of all sorts were used wherever perfumes

were abundant. But while in most early civilizations other cosmetics were largely confined to the female sex, not so with perfumes. Men and women vied to make their bodies more fragrant. In many periods perfumes were more widely employed among the males, and on some occasions their use was the exclusive prerogative of the most masculine, athletic, and warlike of men.

There are extant today a few Egyptian formulas and many references to the ingredients that were at the disposal of the perfumers. Found among the relics of Egyptian life are many boxes of all sorts for holding perfumes, the forerunners of our own beautiful *flacons*.

In the fourth century before the Christian era, the conquests of Alexander the Great brought the center of civilization to Greece. The Greeks found in perfumery the source of medical aid and sensual joy. Hippocrates, father of medicine, mentions the therapeutic value of numerous perfume substances. The Greek island of Cyprus becomes the name of an elegant perfume. The use of perfumes at funeral services is mentioned by the Greek historians.

In the recently unearthed civilization of Crete, which thrived on that Mediterranean island many centuries before the dawn of the Greek culture that has come down to us, there must have been an interest in perfume materials. The Cretan developed the art of body adornment. Such aromatics as mint and wormwood were known to him. But we know hardly enough about his life to reconstruct this aspect of it.

Greek mythology has many episodes in which fragrance is prominent. When Aphrodite places Paris on his marriage-

bed, after saving him from Menelaus, Paris is saturated with powder and perfume. Later, when Hera goes forth to aid the Greeks in the battle with the Trojans, she is dressed in beautiful clothes, is perfumed with seductive oils. In the epic poetry of Homer many equally interesting references are found.

That the Greeks should have embraced the art was inevitable. Side by side, this was the land of pleasure and stoicism. The women of Greece loved perfumes, and the men bathed in the oils. Different odors were used for the various parts of the body. Use led to abuse. At Xenophon's demand, Socrates urged caution in the use of fragrant ointments and oils, but the Greeks were in no mood to listen to their venerable philosopher. Among the perfumed, Socrates warned, one could not distinguish the free man from the slave.

The Greeks made offerings of incense, but they preferred to keep the oils for themselves. Only the Spartans were unaffected by the perfume craze. Abstention from the joys of the senses was their byword. Elsewhere in Greece, from Athens to Corintha to Syracuse, indulgence and laziness went hand in hand. Sweet odors went with exciting drinks. The Bacchanalians were dragging Greek civilization downward.

The Greeks gave us the great figures of mythology, who employed perfumes; the great poets, who sang of perfumes; the great scientists, who made remarkable studies of the art of perfumery.

The land of the first Olympics and the birthplace of true

democracy had outlived its usefulness as the fulcrum of the cultural world, but during its reign the Greeks had protected and sponsored perfumery, and passed the art on to the new leaders of world culture and civilization, the Romans.

It was not alone from the Greeks that the Romans learned of the art of perfumery. The Carthaginians, whom Hannibal led in his disastrous military expedition, used odorous matter to adorn the body. Men indulged in perfumes in the days of Lucullus and Cicero; in one of the latter's orations he harangued these men for their indulgences. When Antony returned from Egypt, he brought to Rome the influence of Cleopatra on the art. The terrible Caligula bathed in perfume.

The Roman indulgers had their counterparts in the Roman stoics. Caesar spurned men who came to him all scented. "I would rather you smelled of garlic," he said in scorn.

The Romans were great traders. They brought perfume from Greece, Palmyra, and Arabia, and from overseas imported labdanum, cinnamon, myrrh, aloes, and incense. No less a historian than Pliny complains bitterly of military campaigns undertaken in order to bring perfumes to the Romans.

Roman use of perfumes went to excesses. There were perfume festivities, great banquets at which perfumes sprayed forth from statuettes.

Many of the names associated with Roman history are well known in the annals of perfumery. They include the violinist, Nero, of whom it is written that he used more

perfumes in a single funeral procession than could be produced in Arabia in ten years. Against such excesses laws were passed, but to no avail.

Roman perfumery began to resemble the present-day science in many respects. The perfumes were enclosed in bottles, frequently made of glass, some of which could easily pass for a perfume container of today. Others were made, in the case of valuable creations, of onyx, while the common materials were enclosed in clay.

Roman perfumes were sold in a solid, liquid, or powdered form. The liquid perfumes were somewhat suggestive of modern alcoholic solutions; they were solutions of odorous materials in oils.

In some cases the perfumes were made up of a single aroma, taken from one plant; in others, we have the beginnings of the modern bouquet. A material might be a rose perfume, or a narcissus; while the bouquets contained many oils, the more the better.

In the Italian peninsula, the custom of the Greeks in choosing different odors for perfuming various parts of the body was copied. Odors were sprayed in abundance all over rooms and palaces. Even domestic animals were perfumed.

The profuse use of perfumes at the banquets and their places on the menus gave rise to this poetic repartee. Wrote Catullus:

> And I can give thee essence rare
> That Loves and Graces gave my fair;

So sweet its odor flows,
Thou'lt pray the gods "May touch and taste
Be quite in smell alone effaced,
And I become all nose."

To which Martial gave reply:

Faith! your essence was excelling,
But you gave us nought to eat;
Nothing tasting, sweetly smelling,
Is, Fabullus, scarce a treat.
Let me see a fowl unjointed
When your table next is spread;
Who not feeds but is anointed,
Lives like nothing but the dead.

From the fall of Rome until the Renaissance, the developments in perfumery, as in medicine and many other sciences and arts, were found primarily among the Arabs and the Persians. In the valley of the Sabaeans, olibanum, best known of the ancient perfume materials, grew in abundance. Many centuries before, the Arabs had developed spices and myrrh and had built in these commodities a foreign trade of enormous economic and historical importance.

Among the Persians the use of perfumes was largely confined to the sensual and the aesthetic. The odorous burials and sacrifices assumed secondary importance. In their stead there were excessive personal uses of perfumes. The bodies were bathed in fragrant water

These peoples played a particularly significant role in the development of the science of distillation. They left their imprint on the language of perfumery, notably in such words as "attar of rose," which is traced to the Persian, *'atar*, meaning "essence," and *'atara*, "to smell sweet"; and again in the word "alembic," which comes from the Arabic, *al-ambīq*.

The discovery of the value of alcohol to perfumery probably dates back to the fourteenth century. This was an inevitable development in the art. It gave to perfumes a vehicle in which they could be conveniently carried, a substance that would dissolve them without leaving an objectionable odor, that was not greasy, and that would not stain. Looking back, one can almost consider that modern perfumery begins, so to speak, from this time.

The first alcoholic perfume solutions may have been the so-called "Hungary waters." The origin is obscure; the medieval literature does not mention such solutions until two centuries after they are said to have been introduced. The term "Hungary water" survived almost up to the twentieth century; it came to be associated with a rosemary odor, perhaps a hint as to the origin of the term.

The Renaissance brought a revival of all the arts, and once again perfumery began to flourish, now with Italy as its center. It was Catherine de' Medici who is credited with having been the patron saint of the art in France. She came to France to marry Henry II and brought with her a private cosmetician and perfumer, a young man whom she

called René. She took a personal interest in the cultivation of the French flowers for perfumes and sponsored the development of that industry.

In France the art began to attract the attention of the alchemists. The courts became the center of perfumery. Ladies and gentlemen of the royalty and the upper classes used odorous substances extravagantly. Excess was denounced, as it had been in Greece and Rome, but again to no avail. Different courts had different odors. In some courts each day of the week had its own scent.

In France, Italy, and England, during the years of the ascendancy of the art of perfumery, the styles called for perfumed gloves. Two professions were intermingled and inseparable, that of *parfumeur* and *gantier*. In the early formula books, fragrant gloves played a dominant role, and this fashion held sway for several centuries.

There are delightful passages about perfumery to be found in many of the classics, one of the most interesting being the satire on the excessive use of aromatics, even in the perfuming of money, in *Don Quixote de la Mancha* of Miguel de Cervantes:

> "I do not deny thee thy wages, honest Andrew," cried the master; "be but so kind as to go along with me, and by all the orders of knighthood in the world, I swear, I will pay thee every piece, as I said, nay, and perfumed to boot." "You may spare your perfume," said Don Quixote; "do but pay him in reals, and I am satisfied."

Across the Channel perfumery was having a checkered career. It was encouraged by several of the queens and denounced by many men of state. In 1770 there was sponsored an act of Parliament, reading:

> That all women, of whatever age, rank, profession, or degree, whether virgins, maids or widows, that shall from and after such Act, impose upon, seduce and betray into matrimony any of His Majesty's subjects by the scents, paints, cosmetic washes, artificial teeth, false hair, Spanish wool, iron stays, hoops, high heeled shoes, bolstered hips, shall incur the penalty of the law in force against witchcraft and like misdemeanors and that the marriage, upon conviction, shall stand null and void.

We wonder how many such annulments were granted by male judges sitting on their benches, with their long, carefully curled false tresses hanging from their bald heads.

Men as well as women were still using perfumes. During the reign of Louis XIV the extravagances with the art declined, and the king himself used little perfume.

It was to be expected that France would develop as the center of modern perfumery. Geographical and climatic conditions dictated that in southern France, in the region of Provence, the cultivation of flowers for their oils would become a great industry. It remained only for man to develop and perfect satisfactory methods for extracting the oils in an economical and practical manner.

In the latter part of the eighteenth century, the essential-oil and flower-oil industries began to thrive in that region. A firm that has since risen to the pinnacle in the field traces its history to its first owner, who in the years before the French Revolution would load the lavender on the backs of his donkeys and lead them to town, there to dispose of his aromatic plants.

At the end of the seventeenth or the early part of the eighteenth century, an Italian by the name of Paul Feminis, doing business in the German town of Cologne, brought forward a new and fragrant mixture which, according to some of the perfume historians, became the sensation of the day.

L'eau admirable, as this new product came to be called, was based primarily on Italian citrus oils, néroli, lemon, bergamot, with some lavender. It differed radically from the Hungary waters of its day, insofar as it was not built up around a single floral note but was a bouquet giving an effect that was a departure from natural odors.

About one hundred years later, the historians tell us, a descendant of Feminis, Jean Marie Farina, made some modifications and modernizations in the formula and put out his product under the name of Eau de Cologne.

Farina had more success with his Eau de Cologne than he had bargained for. Every perfume house of the time copied his formula. They put out their mixtures under the name of Eau de Cologne, and since they were doing business in that city on the Rhine, the courts upheld their right to the words, despite Farina's protestations.

The originator had one advantage. Everyone had come to know the name of Farina; so he labeled his product with his own name, the one, the only, the original Farina Cologne.

Now, the Farina family was very prolific. There were brothers, sisters, aunts, uncles, nephews, and cousins, and since they were all blessed with the same last name, the Cologne perfumers took little Farinas and big Farinas into their business, and all of them had the wondrous name on the label. For many decades the legal battles over the right to the Farina name raged unabated.

To the present day, the name of "eau de Cologne" has survived. The contribution of its creator to the art of perfumery was the popularization of a bouquet rather than of a perfume identified with the scent of a flower.

The introduction of eau de Cologne was the last great effort to shift the center of the perfume world into Germany. The developments of France and her colonies in the growing of oil-bearing plants was a greater influence on the industry than Germany's advances in the science of chemistry.

By the middle of the nineteenth century, if not earlier, France's supremacy was unchallenged in perfumery. A new influence had settled the doubt, if any still remained; that was the rise of Paris in the world of fashion.

The two arts were destined to be closely intermingled. The great fashion experts of Paris, the world-renowned *couturiers*, embraced perfumery and were among its most famous sponsors. Many are the names of French perfumers

and perfume houses that originally were—and to this day are—the style setters in women's clothes.

It is now forty or fifty years since some of the great French perfumes have appeared on the market, and in recent years there have been some outstanding creations in America and elsewhere. What years they have been for the science and art of the creation of odors!

CHAPTER 2

Sweet Odors for Jehovah

And we are not told whose gift was gold
Or whose was the gift of myrrh.

EDMUND VANCE COOKE

ON the night that has changed the history of the world, the most significant date in all recorded time, King Herod sent out the wise men to find the newborn prophet. These wise men followed a star in the east, the famous star of Bethlehem, and the star, like a compass, led them to their destination. They fell before Mary, and they worshiped her son, and they presented her with gifts, as offerings of thanks because she had brought forth the Son of God.

What were these gifts that were presented by the wise messengers? They were gold and frankincense and myrrh.

It is not at all surprising that materials associated with the beginnings of perfumery should have been mentioned at this point in the Gospel according to St. Matthew. For the Bible is replete with references to perfumes, as sacrifices to God and as beautifiers for the men and women of the pre-Christian era.

In the first book of the Pentateuch, the Ishmaelites who bought Joseph into slavery from his brethren were traveling "with their camels bearing spicery and balm and myrrh."

And from this passage in Genesis until the end of the Old Testament and in many parts of the New Testament, references to myrrh, incense, and other odorous materials are abundant.

These were symbols of materials most appreciated by men and most desired by God. Whenever gifts are to be offered and sacrifices made, whether to kings and generals or to Jehovah, these substances play a prominent role. When Israel sent his sons to Joseph, he ordered them:

> Take of the best fruits in the land in your vessels . . . a little balm, and a little honey, spices and myrrh, nuts and almonds.

In fact, after the Lord delivered the Ten Commandments to Moses on Mount Sinai, He called Moses up to the mountain again and bade him ask the children of Israel to give a voluntary offering to their God:

> And this is the offering which ye shall take of them . . . spices for anointing oil, and for sweet incense.

In the Bible there is found one of the oldest perfume formulas in existence—a mixture for the preparation of a holy anointing oil, laid down by the Lord:

500 shekels of pure myrrh
250 shekels of sweet oil of cinnamon
250 shekels of sweet oil of calamus
500 shekels of cassia

to which is added one hin of olive oil. Translation of these weights and measures into modern terms is rather difficult.

The hin is equivalent to about a gallon and a half, and the shekel ranges in value from about one-third to two-thirds of an ounce. This oil must have been powerful in odor, and its fragrance was surely of long duration.

In the temples of the Israelites, incense was offered on many occasions to God. And it is possible that in the fragrant substances arising from the burnt offerings there is a key to the origin of the word "perfume," which is derived from two words meaning "through" and "fire."

The perusal of the Bible discloses the use of other materials that have found their place in modern perfumery: the fragrant styrax, boiled from the wood of the stately plant native to Biblical lands, and congealing to a resin of most durable odor; the gummy resin known as "galbanum," of odor sharp and likewise long lasting; the ill-smelling spikenard, which finds favor in perfumes only in minute quantities; the crocus, which is probably what modern industry knows as the strong-scented saffron; the more fragrant costus; the mysterious roseau; the familiar and spicy oil of cinnamon. Indeed a good beginning for the shelf of the perfumer of antiquity!

In the Third Book of Moses a curious light is thrown on the use of frankincense—a hint of perfumes as sauces for delicacies:

> And when any will offer a meat offering unto the Lord, his offering shall be of fine flour; and he shall pour oil upon it, and put frankincense thereon.

This is one of the earliest references in literature to the essential unity of two sciences, that of creating fragrant odors and delicious tastes. In this passage, however, the burning food is used to please the nostrils; man was later to employ fragrant scents to please the palate.

In the Scriptures the Lord constantly reminds His followers that they must offer aromatic sacrifices, and when this is not done, He berates them:

> Thou hast bought me no sweet cane with money, neither hast thou filled me with the fat of thy sacrifices.

What is this sweet cane? It is probably oil of calamus, fragrant and sweet-scented, and used today, though in limited amounts, and in flavors more than in perfumes.

If the Lord called for perfume offerings, He did not always accept them. Valuable as these sacrifices might be, they could not appease Him in His rightful ire:

> To what purpose cometh there to me incense from Sheba, and the sweet cane from a far country? Your burnt offerings are not acceptable, nor your sacrifices sweet unto me.

And what of perfumery to enhance the attractive qualities of a woman? In the Apocrypha there is the story of Judith, who went out to the camp of the enemy, the Assyrians, to beguile the commanding officer with her beauty, intoxicate him, and then behead him. This plan required lavish, flawless, ravishing appearance. So Judith

> pulled off the sackcloth which she had on, and washed her body all over with water, and anointed herself with precious ointment.

Also to be found in the Bible are references to perfume materials for medical purposes. In the house of Simon the leper, a woman poured a precious ointment of spikenard over the head of Jesus; and later Mary anointed the feet of Jesus with

> a pound of spikenard, very costly . . . and the house was filled with the odor of the ointment.

In both cases, the spikenard becomes a subject of debate and recrimination:

> Why was not this ointment sold for three hundred pence, and given to the poor?

But it is in the poetry of the Bible that there is found the fullest appreciation of pleasant odors. In the majestic verse of Psalm 23:

> The Lord is my shepherd. I shall not want. . . . Thou preparest a table before me in the presence of mine enemies: thou anointest my head with oil.

In Psalm 45 there is an imagery suggestive of perfumes for other than sacrificial purposes:

> All thy garments smell of myrrh, and aloes, and cassia, out of the ivory palaces, whereby they have made thee glad.

In the Song of Songs, we find a rich sensuousness of aroma. Fragrance is the inspiration, flowers and their odors the theme. There is hardly a poet in all the history of literature who drew so profoundly from the sensations evoked by odor as the writer of the Song of Solomon.

Thus, the opening verse:

> While the King sitteth at his table, my spikenard sendeth forth the smell thereof.
>
> A bundle of myrrh is my well-beloved unto me; he shall lie all night betwixt my breasts.
>
> My beloved is unto me as a cluster of camphire in the vineyards of En-gedi.

The theme continues throughout the Song:

> Thy plants are an orchard of pomegranates, with pleasant fruits; camphire, with spikenard, Spikenard and saffron; calamus and cinnamon, with all trees of frankincense; myrrh and aloes, with all the chief spices: A fountain of gardens . . .

It is a fitting symbolism that just as the wise men came to Mary on the night that Jesus was born, bearing myrrh and frankincense, so when Nicodemus came to take the body of Jesus after the crucifixion, he

> brought a mixture of myrrh and aloes, about a hundred pound weight. Then took they the body of Jesus, and wound it in linen cloth with the spices.

At the humble festivities of birth and in the painful hour of death the perfume substances of the ancients are offered. Thus begins and thus ends the story of the earthly life of the Son of God.

In these few representative passages there is a deep significance to the modern perfume historian. The emphasis on sacrifice as the chief use of odorous substances is probably a key to the origins of perfumery, but the more sensuous uses of myrrh, the descriptions in the Song of Songs and even the Psalms demonstrate the ease with which the art passed from its original religious purposes.

Throughout the Bible only incense retains its exclusively religious connotation. And incense, like perfume, is a word that means "in fire." The burnt offerings had to be fragrant. "So shall they burn odors for thee," says one passage, from which it is easy to form a chain that will lead to smelling "the savour of your sweet odors" and finally to "the bed which was filled with sweet odors." Perfumery, even in the Bible, had a logic of its own.

If the perfumes of Biblical times lacked the delicacies of the floral oils of the fields of France and the modern developments of the science of chemistry, none could complain that they were too evanescent. Formulated as they were from natural resins, gums, and woods, how these odors must have lasted!

It is easy to be led astray in reading some of the names of Biblical perfume ingredients. Camphire is not camphor, but henna. Myrrh was known by the name of "ladanum," and there may have been confusion between what is known

today as myrrh and what is called "gum labdanum." And what is aloes? It was a wood oil, also known as "lign-aloe," surely the forerunner of our precious modern linaloe.

Out of these oils, gums, and resins the apothecaries, who were the perfumers of the times, created anointing oils, burnt offerings, and sweet perfumes. And Jehovah was pleased, mightily pleased at the results. He kept calling for greater and greater odorous sacrifices.

CHAPTER 3

The Perfumes That Nature Created

Without charm there can be no fine literature, as there can be no perfect flower without fragrance.

ARTHUR SYMONS

WHEN prehistoric man first stepped out of his cave and went forth to find food for himself and his family, he had a keen and indispensable sense of smell. Lacking an organized and accumulated knowledge of where to locate desirable vegetation and meat, he depended upon his sharp senses. Like a bloodhound, he could smell an animal near by and detect whether it was friend or foe, the hunter or the hunted.

But in the dawn of the life of modern man, as we know him, other powers gradually came to replace this odor perceptibility. Man learned to use his thumbs and fingers to great advantage. He forged crude weapons and then developed what at the time were complicated improvements. He discovered how to use his vocal cords, developed language, and communicated thoughts.

The sense of smell was losing its *raison d'être* and began to carry on an ever-weakening battle for survival in the human being. For nature is ruthless in dealing with an

organ without an essential function. In what was probably one stage in the last great evolutionary development of man, the perceptors of odors in the human nose became atrophied. The sharp edges were dulled. The powers of detection became almost extinct, and in place of the protection that it had offered, man turned to his self-created weapons that gave him a distinct advantage over his animal enemies. His nose, unlike that of the other animals that stole through the jungles and roamed the plains, had become almost exclusively a respiratory apparatus.

Almost—but not quite. For as the need for smelling as part of the struggle for existence diminished, it took on a new function. The first man who stopped to stare in admiration at the rainbow forming a myriad of dancing colors in the sky also drew a deep breath of satisfaction at the fragrance of a field of fresh flowers. He had become an aesthete before the perfumes that nature had created.

Nature has indeed been prolific in the creation of the odorous substances found on earth. Most widespread of these materials are those found in flowers and plants, the essential oils that impart the odor. But what are these oils that the plants and flowers contain? How did they come there? What botanical or biological purpose do they serve? What plants are they found in? Where are they hidden in the plants? What are they made of? And how does man obtain the oil for his own purposes?

Actually, every time you pick up a rose and smell it, you are smelling, not the flower, but the oil contained in it. The oil is something you can neither see nor feel, although some-

times a stain on a lady's dress where a flower has been pinned is an unpleasant testimonial to the fact that there was an oil in the flower.

The term "essential oil" is derived from the literal meaning of the word "essential"; that is, pertaining to essences. Synonymous with an essential oil is a so-called "volatile oil," as differentiating from such other oils as the kitchen product, lard; the evil-smelling neat's-foot oil used in the treatment of leather; the candle oil, tallow, or the soap materials, like coconut oil.

"Volatile" is a relative term, referring to the fact that these oily substances evaporate (that is, form vapors) with relative ease, particularly in the presence of steam. The process of smelling occurs when the vapors from these oils hit the nostrils; hence the origin of the expression. Scientifically, all oils are more or less volatile; chemically, the volatile oils are not oils at all. But for the dealers in perfume raw materials the expression is a part of their daily vocabulary.

A third term, "flower oil," was originally used to distinguish between the delicate volatile substances obtained from such flowers as jasmin or rose and the essences that come from other plants. But today, as we shall see, this expression is used exclusively for oils obtained through certain processes of production, regardless of the origin of the aroma in the plant.

There is an aura of romantic mystery about essential oils, one that has surely added to the enchanting delight of perfumery. Strange-sounding names of plants, untranslat-

able into our language, are complemented by the place names of inaccessible and unheard-of spots on earth, associated in the public mind with commerce in essential oils. The names are poetic and euphonious and historic. There is "oil of patchouli," with its several different spellings that the industry cannot agree on; there is "ylang ylang," accursed by every proofreader who thought he had caught an error of repetition. "Bergamot" and "linaloe" and a hundred other exotic words, originating in languages that have barely left their impact on our own, are found on every perfumer's shelf.

Other names come directly from delicious-smelling flowers, bringing to mind the fresh garden aroma of jasmin and hyacinth, narcissus and violet leaf.

It is true that there is not a spot on earth without at least a minor industry in essential-oil production. But, by and large, a few communities have become world centers in the traffic in these products. The growing of the plants and the production of the oil become the big industries of importance to the people.

There is a city in southern France, in that beautiful country known as the Midi; it is a quiet, pretty, and typically French town named Grasse, with inhabitants who number not more than twenty thousand. Grasse is world-renowned. Like Moslems to Mecca, perfumers the world over make their hadj to this township. Its annual harvest figures are awaited breathlessly in all parts of the world, and its first samples after each production are sniffed by experts with noses sharpened by years of sniffing.

Grasse is the central and focal point of the flower fields of France and as such is the leading factor in the world in the development of perfume oils. Its products include the inimitable and irreplaceable jasmin, the golden treasure of the industry, as well as such valuable gems as tuberose, jonquil, rose, narcissus, hyacinth, violet, carnation, and the less delicate but nonetheless popular oil of lavender.

Then there is a little island off the coast of Madagascar, an island whose name is known to everyone associated with perfumery and to practically no one else in America, we daresay. It is called Réunion, but in perfume circles its former appellation has survived even the French Revolution; for its commodities to this very day are called "Bourbon oils."

Réunion in all is less than a thousand square miles in area; in fact, it is about three-fourths as big as the state of Rhode Island, and its almost completely French population numbers less than two hundred thousand. In this dot on the map, lying in the shadow of an island almost the size of a continent, are obtained geranium, ylang ylang, vetivert, and other oils, important substances all, and produced in sufficient quantities to meet the normal demands of the entire world.

There are other producing areas. There are unfamiliar names like Zanzibar and Comores. There is the oil-producing island of Java in the Dutch East Indies, which exports large quantities of citronella, vetivert, and patchouli oils. In the interior of China, at the tip of the toe of Italy, in the valley of the Amazon there will be found one particular oil

indigenous to that soil and territory, and neither war nor the greed of man can successfully transplant the industry to other parts.

America, too, makes its contribution, producing oil of peppermint in Michigan, oil of spearmint, some natural wintergreen, pine oil in conjunction with our Southern turpentine industry, the ancient cedarwood, the rank wormwood, and of course the citrus oils from lemon and orange. We have even experimented in growing such primarily foreign commodities as lemongrass and vetivert. But, all in all, the essential oils produced in this country, though important in their total dollar value and indispensable, particularly in the field of flavors, do not include any of the delicate gems of the industry.

Nature displayed an imagination in choosing the types of vegetable life to carry these oils. They are found in trees and flowers, in lichens, herbs, and shrubs; in short, every section of the vegetable kingdom is represented. But every plant or flower does not contain oil. It can be said that whenever a plant or flower has an odor, it contains an oil; but whether man can obtain that oil, or whether the perfumer would find it worth while, judging its odor value as compared to the cost, would still remain to be answered.

Where are these essential oils located in the plants? They can be anywhere or everywhere; they are found in one part or in many. Each oil-bearing vegetation must be judged separately, but once it is determined in which part of a plant

the oil is located, in a given variety of a species of plant life, there will be no variation from one soil or one harvest to another.

There are oils in the petals. These are among the most precious. There are others in the root. Orris, of the favorite violet character, comes from a root, as does the vetivert. The Sicilian bergamot oil is found in the fruit and cinnamon oil in the leaf and the bark—in each case a slightly different oil. Seeds and petals, woods and peels—all are represented.

And what is the function of these oils in the plants? This is a controversial question that, in the final analysis, we must leave to the botanists to debate. Opinion of present-day authorities is that the functions are many, differing with individual types of plant life.

In the flowers, odors are used to attract insects; these insects alight on the petals, carry off the pollen, and leave it on another flower. The odors thus make possible the reproductive process and the continuation of the species. Judged in the light of our present-day knowledge of evolution, it can be said that the species not having odors attractive to the bees and other forms of insect life, and having no other method of pollination, became extinct.

In the sense, then, that the perfumes were used as a mechanism of the reproductive process, they were sexual in purpose. Yet all plants having essential oils do not reproduce in this same manner. If no other functions could be ascribed to the oils, it would seem that nature had been wasteful of her resources. There are other uses, however

less romantic they may be. They are associated with the processes of respiration, secretion, and excretion, or serve the plants as a protection against changes in humidity and temperature, particularly in regions where such changes occur suddenly and drastically at twilight and again at dawn.

In many such functions fragrance plays no role. The odor of the oils, their most valuable attribute for man today, would seem to have been nature's happy afterthought.

Chemically the oils are very complicated. They do not consist of one single chemical; they are rather what the chemist calls a "mixture."

This difference between a chemical compound and a mixture is more significant to the perfumer than may first be apparent, and merits a word of elucidation. If the perfumer takes any two liquid chemicals that are ingredients of a formula and mixes them together, he is likely to obtain a homogeneous solution. There may be one layer; it may not be cloudy; it may look, feel, taste, and appear like one chemical substance. But there remain in the glass two different chemicals, separable from each other by various means, and the mixture (or solution) has no properties other than those of its two constituents. It can be said to have no chemical identity of its own.

When the chemist has nitrogen and hydrogen, on the other hand, and causes them to interact with each other under proper and favorable conditions, he obtains a substance called "ammonia." Ammonia is neither hydrogen nor

nitrogen, nor is it merely the sum of the two. It has its own characteristics, its own mode of existence.

Ammonia is a chemical compound, as are water, ethyl alcohol, and numerous substances found on a perfumer's shelf. But essential oils, on the contrary, are mixtures, one oil usually containing many different chemicals. We cannot take oil of jasmin, represent it by a single chemical formula, and then proceed to create this same chemical in the laboratory. If this were possible, the essential oil industry would be doomed, its existence made unnecessary by modern chemical developments.

Essential oils are mixtures of many different chemicals, as we have said, but a single substance may be the main contributor to the odor of the oil, or it may make up the overwhelming amount of the oil. Natural oil of wintergreen contains about 98 per cent of methyl salicylate, and the latter is generally known as "oil of wintergreen synthetic," although this name is not scientifically valid.

In other cases, the odorous principle represents a fraction of a per cent, a minute quantity frequently eluding the chemists' efforts to isolate and purify it.

If the oils are varied in their sources in the plants, still more do they differ in their odors. Some of these fall into classes: bergamot, orange, lemon, petitgrain, néroli, all citrus in character, suggestive of a mild but not unpleasant bitterness, a rather sweet tartness. Though classed together, no perfumer could mistake one for another, nor does he find it possible to use them interchangeably.

Peppermint, spearmint, wintergreen, and camphor form a single group. Violet leaf is not unlike orris root. And there is a good deal in the jasmin suggestive of the lilac.

Yet such analogies and comparisons fail us, if we do not take into consideration that the realm of essential oils is a storehouse of separate and distinct odors, strong and weak, pungent and fragrant, cooling and nauseating, sweet and foul, an endless variety, each differing from the other. Each oil has its own indescribable and elusive character, and its own peculiar uses developed by the artisans in perfumery through the centuries.

Sometimes a chemical is found in the oil of one plant, and in no other. Benzaldehyde, as an example, is seldom encountered in natural sources except in oils botanically related to bitter almond.

Other chemicals turn up with monotonous frequency whenever an oil is analyzed. Geraniol, named for the geranium flower in which it is found, is present in oil of citronella, gingergrass, palmarosa, attar of rose, and a host of others, and to each it blends with a variety of other chemical constituents. In each it is present in a different quantity, has different companions, and makes up a different formula. It can be said to be making the same contribution to varying perfumes.

Only in the last century has the chemist begun to unravel the make-up of these substances. In the days of the beginnings of organic chemistry, scientists thought that for a chemical to have odor, the carbon atoms had to be arranged

in the form of a ring. They depicted this cycle as an imaginary hexagon, and they called chemicals of this series by the name of "aromatic."

The term has remained, and like so many other scientific names, its original historical connotation has long since been discarded. The chemist learned that many odorous substances do not form rings at all. They seemed to be made up of two units (or molecules) of isoprene, joined together in different fashions.

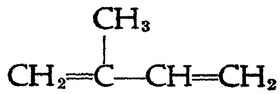
Now isoprene became a household word in the early stages of the war. It is the building block of natural rubber. In the caoutchouc hundreds or thousands of these little units, which consist of five atoms of carbon and eight of hydrogen, in a special type of arrangement, are joined together. The chemist refers to the formula of natural rubber as $(C_5H_8)x$, not being able to determine exactly what x is equal to.

If we make x equal to 2, then our formula becomes $C_{10}H_{16}$, and this is what the early investigators of essential oils found that many of the chemicals in perfume oils consisted of. In fact, so many different chemicals had this formula, that there seemed to be considerable confusion.

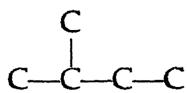
Most chemicals made up of ten atoms of carbon and sixteen of hydrogen called "terpenes." When oxygen is introduced into the molecule, then the group is called by the long though logical name of "oxygenated terpenes." It is in this latter class that hundreds of essential-oil constituents are found: geraniol of geranium fame; linaloöl

from bergamot oil; rhodinol and citronellal, both with rosy odors; citral, which is found in Indian lemongrass; and other perfume chemicals too numerous to mention.

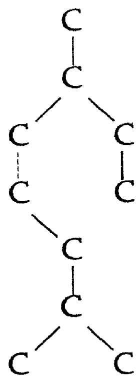
Let us illustrate how this works. The C_5H_8 formula which we have mentioned must have a certain arrangement of these thirteen atoms. The arrangement is known as the "structural formula," and in the case of isoprene it works out like this:



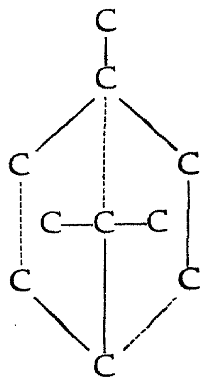
If we should remove the hydrogens and leave these five carbons attached to each other in this special manner, four in a row and another stemming from the second, we would have a skeletal arrangement, or we might call this the "carbon skeleton of the isoprene molecule," and this is what it would look like:



Joining two of these isoprene units together in various manners, we can work out the carbon skeletons of these perfume materials. In the following diagrams, for which we are indebted to A. J. Haagen-Smit of the California Institute of Technology, the points of connection between the isoprene units are shown by a broken line:



Geraniol



Camphor

Not all the constituents of essential oils bear this relationship to isoprene and the terpenes, but large numbers do, and they must have been produced in the plants by similar biosynthetic or biochemical methods. But how the plant succeeds in synthesizing these chemicals, what it uses as its raw materials, and where it obtains them is not within our province at this time.

But of one thing we are certain—the plant manufacture of these oils is a delicate process, perhaps as complicated as anything in the realm of botany. The agriculturalist must deal with a commodity that is the prima donna of plant life. He must work to grow not only a satisfactory number of pounds of plant per acre, but his flowers must give the anticipated yield of oil, and this oil must reach the standards of the industry, set up both by the chemist and the perfumer.

The factors that enter into this agricultural problem are as manifold as they are vital. A change in fertilizer will

affect the production, as will a change in soil. Differing varieties of the same floral species do not produce similar oils under exactly the same conditions, and the same varieties produce entirely different oils (or none at all) in different soils and climates.

The plants are sensitive to heat and cold, moisture and humidity. Insect life affects their output. Sunlight and shade, altitude and density of air also leave their marks. Not all the plants and flowers can be harvested when they are fully ripe. There are different stages in cultivation, which give variations in the quantity and quality of the oil. Some of these plants grow wild and produce oil in spite of the carelessness of man. Others need constant nursing.

The centuries have developed what seem to be the ideal spots in the world for most of these oil-bearing plants. Even world blockades and the starvation of the industry in America brought few changes of a permanent nature.

Perfumery develops dynamically, finds new tools, and improves old ones. The chemist is constantly delving into new secrets in his studies of these oils. But for the oils themselves the perfumer still looks longingly toward a small town in the Midi and a minute island in the Indian Ocean.

CHAPTER 4

From the Petal to the Shelf

But earthlier happy is the rose distill'd
Than that which withering on the virgin thorn
Grows, lives, and dies in single blessedness.

WILLIAM SHAKESPEARE

THE quest for new and more efficient means by which to gather odorous oils from flower and plant is as old as the recorded history of man. Crude apparatus reminiscent of the modern distillation equipment is found roughly drawn in our inheritance of Egyptian culture, and even the treatment of petals with fats had its forerunner in ancient times.

There are today five major methods of performing this function. They differ from each other not only in mode of operation, but in applicability to the various types of plant life, in cost of producing the oils, in yields obtained, and in the types of oils produced.

Least expensive and probably oldest of the five methods is steam distillation. To understand this process, let us briefly review the theory on which it is based.

All substances can exist in three different states or phases; that is, in the form of a solid, a liquid, and a gas. The phase of a substance is dependent upon the temperature and

the pressure, and as we are most familiar with materials at room temperature and at atmospheric pressure, we generally speak of them as being "solids," "liquids," or "gases," overlooking the ease with which some of them can pass from one state to another.

By applying heat to a solid we can usually convert it into a liquid, and then by reversing the process we can cool the liquid and it will solidify again. In the same way, if we heat a liquid, we can usually bring it to a point where it will start to vaporize; this process is called "evaporation," and the temperature at which it occurs is known as the "boiling point." At this point the liquid will change into a vapor, or a gas, and then the vapor can be cooled to a temperature below the boiling point, and it liquefies again. This last process is called "condensation."

This is the way most, though not all, substances behave. Some chemicals, on the other hand, can pass directly from the solid to the gaseous state; this is called "sublimation." Many liquids, when heated, will not vaporize, but break up or decompose.

Now, if a liquid substance is placed in a container, it exerts a pressure on the walls of the container in which it is kept and on the air above it. This internal pressure, or "vapor pressure," as it is called, increases with the application of heat. When the vapor pressure has reached a point where it is equal to or greater than the pressure from the atmosphere that is seeking to hold it down, then the liquid will begin to vaporize.

In distillation, the substance, upon vaporizing, seeks an

outlet. Proceeding through the only available outlet, it is cooled and again liquefies. This condensation is usually hastened by passing cold water through a jacket around the condenser. The collected liquid is known as the "distillate," and the material remaining behind, whose boiling point has not yet been reached, is known as the "residue."

Steam distillation represents an important modification of this process. When certain substances are boiled in the presence of water, or with steam being introduced into the receptacle, the heated water generates an internal pressure. When the pressure of the water and that of the substance being boiled with it become equal to or greater than the pressure of the atmosphere, the mixture of water and the second material will boil. The other substance therefore no longer requires the same amount of heat to reach a boiling point as would be necessary without water, because the vapor pressure from the water takes care of most of the pressure from the air.

This simultaneous vaporization occurs in a fixed ratio. If at a given temperature the vapor pressure of the substance is one-tenth that of the atmosphere, then the vapors will consist of nine-tenths of steam and one-tenth of the second substance, by volume.

This mixture of the vapors proceeds together to a condenser, where the two substances are liquefied and drop into a receptacle where they are collected.

Distillation is carried out in a still, usually consisting of an enormous pot or kettle, with a tightly fastened cover. In the cover is an opening connected to a tube, which leads

the vapors to a condenser. The latter generally consists of a coil, arranged in a jacket or tank. Cold water flows into the jacket at the bottom and is forced out at the top.

In the production of essential oils, the plant is placed in the still, which is usually made of copper. Water is introduced into the still, or in more modern equipment steam is added directly, and the heat of the water or steam breaks open the cells in which the essential oils are imprisoned. The simultaneous vaporization and condensation then take place.

The final stage of this distillation is a simple separation. Oil and water are immiscible. The water, usually the heavier, settles to the bottom, is carefully drained off, and the oil remains.

Indeed, one might think, a simple process, but there are many difficulties. For one thing, the heat of the steam can bring about many changes in the oil. Water itself reacts with large numbers of organic chemicals; such a reaction is called "hydrolysis." Ethyl acetate, for instance, a sweet and perfumy substance, can be split up to form ethyl alcohol and acetic acid, and neither by itself nor a mixture of both has an odor suggesting the original compound.

Another disadvantage of steam distillation is found in that some of the components of the essential oils may be rather soluble in hot water. By and large, organic chemicals are not water-soluble, but there are exceptions, particularly among compounds of lower molecular weight and the alcohols. Thus, some of the phenyl ethyl alcohol, with its definite rosy note that contributes so much to any rose per-

fume, is lost when oil of rose is produced by steam distillation. Most of this product leaves the oil and goes into the water; the water, in fact, can be sold as a mild-scented cologne, known as "rose water."

On the credit side of the ledger for distillation as a method of producing volatile oils is its economy. It gives oils of good yields, does not cost much to operate, consumes no large quantities of raw materials other than the usually abundant water and fuel, and the same apparatus can generally be used for numerous types of plants.

Many of the industry's most delicate and expensive flowers cannot be treated in this manner. It is a process reserved for twigs, woods, leaves, and other hardier parts of plant life. A few flowers are exceptions: the rose, orange blossom, and ylang ylang are steam-distilled. However, most flower oils are too easily altered under high temperature to withstand such drastic treatment and their great values justifiy more expensive operating methods.

One of these more expensive methods is known as "enfleurage." It is a process that has undergone little change in the past few centuries, and its method of operation is out of keeping with the picture of modern civilization and the tempo of present-day life.

Even the language of enfleurage is untranslatable into our tongue, so linked is the process with the French producers. It has been described in English as "cold extraction with fat" and translated by some as "inflorescence," a term that has not been assimilated into our language.

It is an amazing thing about the enfleurage process that

more oil is obtained from a flower than was present in the flower. In 1897, Jacques Passy, noting this phenomenon, offered an explanation. These flowers, he wrote, "do not contain their perfume all formed, or contain only an insignificant quantity of it; the flower produces it and exhales it in a continuous fashion." Enfleurage is possible, the author continued, "because this process respects the life of the flower."

After the flowers are picked in the fields, they are brought to the near-by factories, where within a few hours they are placed, by hand, on layers of fats, made up primarily of a highly refined lard. These fats are laid out on both sides of a framed glass, known as the chassis (pronounced *shahsee*), where the petals remain for about twenty-four hours. The fats are known as the corps (pronounced *core*). During this period the flowers continue to manufacture and exhale their perfume, and the absorbent fats capture and hold the oils. The chassis are placed on top of one another, so that the perfume cannot escape and be lost in the air.

After a day, the chassis is shaken so that the petals fall off, and those that do not come off easily are picked by hand, and on the other side a new group of petals is placed.

What a painstaking process for these days of mass production and laborsaving devices! Each petal to be placed on the fat by hand, and many taken off by hand, with special care that it is in sufficient contact with the corps to permit ready absorption, and sufficiently loose to be taken off without having more than a negligible amount of the fats cling to it.

The same corps is used over and over again for several weeks, and when it is saturated with the perfume oil, it is removed. It is heated up slightly, melted, and then frozen into a uniform, semisolid body, a waxy substance called a "pomade."

Once these pomades were used directly in perfumery. They had a slight scent of fats, which was more than overcome by the powerful concentration of the fragrant perfume. But latter-day perfumery found these pomades difficult to handle and preferred to make an extraction with alcohol. The alcohol is agitated in the pomade and the perfume dissolved in the alcohol, finally passing completely from the fats.

From these alcoholic washings, there is obtained the "lavage de pomade," or pomade washings, which are alcoholic solutions of the flower oil obtained by enfleurage. It is not difficult to remove the alcohol and leave a pure flower oil. This is accomplished by a process known as "vacuum distillation," generally referred to by its Latin term, "distillation *in vacuo.*"

The principle of vacuum distillation is not unlike that of steam distillation, but the method of arriving at the same end differs. When the atmospheric pressure is reduced by the creation of a partial vacuum, it requires only moderate heat to overcome the small partial pressure remaining inside the still. When the amount of pressure approaches zero, but never reaches it, we have what is almost a complete vacuum, and many substances evaporate at very low temperatures. Thus, vacuum distillation avoids heating an

oil up to a temperature that would be deleterious to its quality.

By vacuum distillation, the alcohol is removed and the oil remains. This oil is called the "absolute of enfleurage," or the "absolute of pomade," although the term "absolute," by itself, when applied to flower oils is generally not used in reference to the enfleurage process.

Enfleurage is today in use primarily for two flowers, jasmin and tuberose, and for it only the most perfect flowers are employed. If the flower has been left standing too long, or if it has been bruised in the picking, it may undergo a putrefying process while on the chassis and adversely affect the odor of the oils.

The petals that have been picked and already used for enfleurage are not thrown away. They still have some perfume oils which had not been absorbed by the lard, and they also contain waxy material of definite perfume value. These partially exhausted flowers are subjected to extraction with volatile solvents, a process which we shall describe presently, and the oils obtained are known by the name of "chassis"; if the flower is jasmin, this oil is called "jasmin chassis."

The enfleurage process is delicate. It is associated with carefully guarded secrets and techniques belonging to each house. The absolute of enfleurage of one particular brand has a special character of its own, and in order to guard that typical note, the big producers grow their own flowers on plantations owned by the factories. From the fertilization

to the harvesting, they can control every stage of the production of the flower and the oil.

There are quite a few smaller farmers engaged in growing these flowers, who naturally are unable to own their factories for making the oils. The larger firms are unwilling to buy the flowers and mix them with their own, and these big producers have therefore set up a community factory, known as the "cooperative." Peasants come with their horses pulling old broken-down wagons laden with flowers, which are deposited at the foot of the community factory.

Another term in common usage is the *communelle*, and it is characteristic of the industry that this frequently used word has different meanings for different authorities. In general it represents an oil produced from a mixture of various lots of a flower. These flowers may have been bought by the producer from different smaller growers or they may represent a mixture of the oils produced from his own flowers over a period of time.

The absolute of enfleurage strongly resembles the odor of the living flower but is not an exact duplication of it. By some perfumers it is treasured as the *ne plus ultra* of the essential-oil industry. Rooted as it is in tradition, with methods originating centuries back, with its secrets passed down by word of mouth and kept within a family, with little literature and less research, this process gives forth an oil that wins the admiration of users the world over.

Some writers refer to the term "flower oil," as distinct from "essential oil," as meaning the oil obtained by enfleurage, solvent extraction, or some method other than

steam distillation. Other writers refer to the oils obtained by these methods as "natural perfumes," as distinct from those obtained by distillation.

Closely associated with enfleurage is the process known as "maceration" or "digestion." The term comes from the Latin, *macerare*, which means "to soften." In maceration, the flowers are immersed in fats that have been softened by heat, and the oils are thus digested.

Maceration differs from enfleurage primarily in that hot fats are used instead of cold. The nature of the fatty corps can be a bit different, but the principle remains the same. Instead of placing the petals on the chassis, they are immersed in the fats.

This method is necessary because some flowers wither quickly, and in the slower enfleurage process either a poor yield is obtained or the death of the flower may cause putrefaction to set in, and decaying odors may corrupt the perfume.

Maceration was more important in the early days of perfume history than it is today. As a process, it is now almost extinct, though here and there in Grasse the equipment for hot-fat extraction is still found. The flowers that lend themselves neither to steam distillation nor to cold enfleurage, and that once were subjected to digestion, now find greater favor in extraction with solvents. Its main use at this time is for the French rose, known as the *rose de mai*, and to a smaller extent it is found in the production of oils of orange blossom, mimosa, and hyacinth.

During the nineteenth century considerable experimenta-

tion was conducted by French and German chemists who agitated various flowers in common chemical solvents. By a solvent is meant simply a substance in which another substance will dissolve. Water, misnamed the "universal solvent," has little or no dissolving influence on essential oils. But the oils are usually soluble in alcohol, petroleum ether, carbon tetrachloride, sulfuric acid, acetone, benzene, chloroform, and other inexpensive chemicals.

The history of this process is generally traced back to Robiquet, and it dates back to 1835. Robiquet experimented with jonquil flowers in ether, but his experiments came to no avail and one of the most important advances in the history of the industry was almost lost.

Robiquet's work was continued as a laboratory curiosity. It was not until a generation later that it was taken up by Millon, who, while preferring ether, demonstrated that oils could be obtained with carbon tetrachloride, benzene, and other solvents. Millon, in association with Ferrand, was awarded a patent, the first of its type, from which, however, no material benefits were to be derived by the inventors.

The process continued to attract the attention of many of the illustrious names in the field of chemistry, chemical engineering, and perfumery. But it found no commercial application, perhaps because the poor quality of the solvents was a handicap in producing a good oil in an attractive yield, and because an inexpensive method for the evaporation of the solvent and its recovery, without harm to the oil, was a problem that required a solution.

Many names are associated with the gradual development

of a commercially practicable process: Will Egrot, Hirzele, Nardin, Vincent, Massignon, Louis Roure, J. Robert, Garnier, Otto. By 1890, the method began to receive acceptance, at the very time when perfumers were beginning to turn toward synthetics and organic chemists toward perfumery.

The principle of extraction with volatile solvents is based upon the readily understandable idea that when the flowers come in contact with petroleum ether, benzene, or other solvents, the oils will dissolve. Giant apparatus, known as extractors, are charged with the suitable solvent and the flowers. These flowers may be placed on grills, separated from each other, and the extractor can rotate or the solvent can flow past the flowers over and over again in much the same manner as coffee in a percolator.

The evaporation or removal of the solvent leaves a concentrated oil, known as the "concrete," which must be purified. The concrete has been called by some experts the truest reproduction of the natural flower oil that man can obtain.

The concrete is extracted in many times its own weight of alcohol, in an apparatus known as a *batteuse*. A group of several of these *batteuses*, usually ten, is called a *batterie*. The alcoholic solution is frozen, with waxy substances coming out of solution. These alcohol-insoluble materials removed, the alcohol can be evaporated and recovered, and we are left with the beautiful, expensive, and easy-to-use oil, the "absolute."

Extraction is a relatively expensive process. The choice

of a solvent is not an easy one. Solvents differ in their costs, give varying yields, have different effects on the oils, and present varying problems for their removal. Some solvents are less likely to dissolve the undesirable waxes with the oils; others will dissolve waxes, resins, and colored and viscous material of all sorts.

But in this process there is a consumption of labor, of raw materials, in some cases a loss of solvent, and with most flowers a diminished yield, which would make it prohibitive except for the costly flower oils. An oil that sells at $1 or $2 a pound is still dependent on steam distillation and, if its character suffers, at that price one cannot complain.

If the plants are taken fresh, before being dried out, they contain a great deal of water, but for some plants the drying process would destroy the perfumes. Yields can be as little as 0.04 per cent, based on the undried flowers, which would mean that we would get less than a pound of oil from a ton of flowers, as is the case with gardenias. The yields can range in the neighborhood of 1 per cent for flowers like mimosa, as high as 6 per cent for patchouli, almost 9 per cent in some exceptional cases with sandalwood, and 18 per cent with clove oil.

For jasmin, there is obtained a concrete by extraction ranging from 0.28 to 0.35 per cent, and of this about one-half remains in the form of an absolute.

It can readily be seen that extraction with volatile solvents, maceration, and enfleurage are all related processes. They involve the physical process of absorption or solu-

bility. The fifth process is, however, a complete departure from those described above.

Expression, as the name implies, is based on physically pressing parts of plants, preferably the peels, until the oil is squeezed out. The expression may be accomplished by mechanical pressure, or hand squeezing, or both. The cells containing the oils are broken open and the oil runs off. Expression is used for the peels of fresh fruits that are very rich in oil. Among these are lime, lemon, bergamot, and orange.

In Sicily and in Brazil primitive expression methods are still to be found. One method consists of scraping the peels, letting the oils escape, and then sponging them up. The saturated sponge is squeezed into a suitable can. Other more complicated methods involve the use of concentric revolving plates, and in America, at least, one will find hydraulic presses.

The oils obtained by expression are known as the "cold-pressed"; if machines are not used, they are called the "hand-pressed."

After the essential oils have been obtained by one of these processes, some of the less desirable ingredients can be removed. Those oils that are rich in terpenes, the hydrocarbons of the $C_{10}H_{16}$ series, are frequently treated to remove some or all of the terpenes. The latter are low-boiling, easy to evaporate, and have little odor value. Users of citrus oils, particularly, are fond of having the more valuable residues, which are called "terpeneless oils." The terpeneless oils are much stronger in odor value, display

better solubility in mixtures of alcohol and water, and are more stable than the original oils. A terpeneless lavender is described by one manufacturer as being twice as strong as the oil of lavender, a terpeneless oil of grapefruit thirty times as strong, and terpeneless oil of mandarin sixty times as strong as the untreated oils.

Having devised these various methods of producing the oils, the industry was then faced with a second major problem: how to get the true oils to the shelf without the tampering of greedy and dishonest men.

Adulteration of the volatile oils is called by the very high-sounding name of "sophistication." It is facilitated by the fact that the oils are themselves mixtures, and that they do not have the same percentage of the different ingredients from one year to another and from one maker to another.

Some of the chemicals found in the most expensive of the oils are produced by the chemist in the laboratory, at a very low cost. And, what is more, the variation in the amount of such a chemical that may be found in the oil is a temptation to which many unscrupulous traders have bowed.

Thus natural jasmin, selling in America in 1945 as high as $100 an ounce, contains benzyl acetate. This chemical can also be made synthetically for about $1 a pound. Benzyl acetate may make up 65 per cent of one sample of natural jasmin and only 60 per cent of another. If the lower analysis shows up, and yet the higher is still acceptable, why not add a little bit, sufficient to make twenty ounces into

twenty-one, at a profit of $100 and at a cost of only about 25 cents or less?

Cheaper oils have been added to the expensive ones in this adulteration game. Oil of turpentine is a favorite adulterant for terpene-containing oils. Many chemicals not found in the original oils are added, as they are not simple to detect.

The detection of sophistication has been a knotty problem for perfumers and their chemist colleagues. A strange literature, perhaps unmatched in any other field of science, has arisen round the sophisticators. It is akin to that of the art dealers and bookworms, who have devoted their lives to the detection of the forgers in Renaissance masterpieces and first editions.

The chemist has devised many means for the detection of adulterants. Oils are put through rigid analytical tests. Sharp and knowing eyes watch for unusual specific gravities, refractive indexes, optical rotations, total aldehyde, ketone, alcohol, or ester content. The adulterating chemical, while it may allow the oil to pass one of these tests, can hardly hope to go unnoticed through all of them.

But the trade-mark of the original grower, distiller, and packer has come to have an enviable reputation in the field of perfume oils. The sealed container of one of the better known Grasse houses is a mark of repute built up through much patient work, in the years when competition with the adulterers was difficult because the perpetrators of fraud could set low and attractive prices.

Through confidence in the industry at Grasse and in the

few other oil-producing centers of the world, through the accumulated studies and published findings of ingenious chemical detectives who set themselves on the trail of sophistication, through the methods of up-to-date analytical laboratories and the standards published by many workers in essential oils, this menace to the integrity of the industry has been overcome.

But all these factors would have been of little avail were it not for the discriminating noses of perfumers the world over. They face an oil like a work of art. Drawing upon memory and experience and imagination, with artistic perception and studious examination, they unhesitatingly name their preferences. Their nose is the final arbiter, from whose decision there can be no appeal.

CHAPTER

The Perfumer's Zoo

I cannot talk with civet in the room,
A fine puss-gentleman that's all perfume.

WILLIAM COWPER

THE imagination of man is intrigued by the idea that animal materials are used in perfumery. And the layman is even more astonished to learn that these products, some of which are revoltingly malodorous, are necessary to give fixative qualities to most good perfumes.

Various animals have been put to use by perfumers for many centuries. In his *Cyclopedia of Perfumery*, E. J. Parry cites references to musk in the tenth and eleventh centuries, and from the writings of Leo Africanus quotes the recording of these gifts to a mountain chief from the Sultan of Fez: "Fiftie men slaues and fiftie women slaues, sixteen civet-cats, one pound of civet and a pound of amber." The amber referred to is ambergris.

Like the essential oils, the main animal oils and resins come from faraway parts of the world, and until recently nothing of importance came from this country. The habitat of the civet cat is the corner of Africa now known as Ethiopia, scene of two wars between the natives and the Italians. The musk deer is found in many almost inaccessible

spots in Asia, chief of which is the legendary land of Tibet. Ambergris is found in the ocean, or washed ashore, anywhere at all, on the most infrequent and unexpected occasions. The beaver is trapped in the cold regions of Canada, and now the muskrat has come forward, the newest contributor to this field, a native of the United States of America.

A small survey of these oils reveals that they include some of the most powerful odorants known and some of the most efficacious of perfume fixatives. One of these animal products is among the most unpleasant scents found in the field of perfume materials; another is one of the most expensive materials in the trade, and a third is no doubt the most important of the new developments in the science and art of perfumery. Indeed a diversified contribution for a small group!

The substance whose odor is so unpleasant is, of course, civet. The civet cat is an animal found in many parts of Asia, such as Bengal, Malaya, Burma, in Java and other islands of the East Indian archipelago, in Ceylon, Formosa, and Africa. It is only the African civet that has been developed commercially for perfumery, and on that continent the development has been restricted to Ethiopia.

The scent pouch of the civet cat is developed in the animals of both sexes. Inasmuch as the civet gives off its valuable secretion when it is being molested, it has been assumed that nature provided these pouches as a protection, in order to frighten away other animals that threatened the existence of the species.

The civet is a wild animal, but when caught it calms down a little. It is kept in captivity, fed on raw meat to increase the output, and then placed in a cage, so constructed that the cat cannot turn around. The animal is teased, and the scent bag is scraped and irritated. Aroused to its full ire, unable to bite, kick, or escape, the civet gives off its odorous material.

Chemically, civet has received considerable attention. It contains some skatole, a malodorous material chemically related to indole and now made synthetically. But the main contribution to the odor of civet is the ketone known as "zibethone" or "civetone," a very high-boiling substance that has also been duplicated by synthetic means.

In perfumery, civet, like the other animal products and many plant resins, is known as a "fixative." Itself very lasting, as would be expected from its high-boiling constituents, it makes the perfume more lasting also. It is said to "round out" or, to use a perfumer's coined expression, "to bouquet" a perfume. In a jasmin compound, for example, tincture of civet will take the rough edges off the benzyl acetate.

Of all the animal products used in perfumery, the one employed in greatest quantities is castoreum. Castoreum, or "castor" as it is called, is obtained from the well-known fur-bearing rodent, the beaver. Like the civet, the beaver has been known for its perfume product for many centuries. W. A. Poucher, in his authoritative work, *Perfumes, Cosmetics and Soaps*, finds references to castor in seventeenth-century literature.

Most of the castor sold in the American and western European market comes from the Canadian beaver, although a Russian product is also known to exist. The castor is found near the genitals of both male and female beavers, but the animal must be killed in order to remove the valuable follicles. Since beaver trapping is a major Canadian industry because of the market for the fur, the sale of the castor may be considered as a by-product. The cost of collection would surely be prohibitive if it were not for the value of the skins.

Castor has an unpleasant odor and taste; the odor is described, in fact, as being "nauseating," but on dilution becomes weaker and more pleasant. It is today sold either as a tincture or as an extract. It is used in small quantities, is a valuable fixative, and finds widespread favor in imparting a "spicy" or "Oriental" note to perfumes. Its dark appearance and tendency to cause discoloration in perfumes is a drawback that must be watched and overcome.

The constituents of castoreum have been studied by many chemists, who report finding benzyl alcohol, acetophenone, and *l*-borneol, among other odoriferous substances in the volatile oil, and in the resinous matter there is a crystalline substance, called "castorin," the structure of which has not yet been worked out. P. G. Stevens of Yale University, whom we shall mention again in connection with his work with muskrats, studied castoreum to determine whether there was a large ring ketone, similar to muscone or civetone, and recently reported that no such substance could be isolated or discovered.

Before leaving the beaver, we should dispose of another animal that has been mentioned as having possibilities for the perfume industry, and that is the lowly and much-maligned skunk. The skunk, too, has a malodorous substance that it can discharge at will, generally as a protection (as many have learned to their discomfort) against man and animal. Some people have worked with this substance in an effort to make it usable for perfumery, in the hope of finding a new source for an American musklike fixative. Nothing of value has come out of these efforts, and it is extremely unlikely that anything ever will. The scent glands of the skunk, like those of the mink, weasel, and other animals, are anal glands, while those of the musk deer, muskrat, and beaver are preputial glands—a difference we cannot afford to overlook. Furthermore, the odor of skunk is believed to be due to an organic sulfur compound known as a "mercaptan," and no one has ever found any extraordinary value for mercaptans in the field of odor chemistry, except to impart to illuminating or heating gases an odor unpleasant and distinct enough to act as a warning signal that the gas is escaping.

Unlike the civet and the castor, the musk that is obtained from the musk deer comes only from the male of the species. The odorous material is definitely not used for protection but is considered to be associated with the sexual attraction between the male and female.

The deer, a small, agile animal, no more than twenty inches high, is killed to obtain the musk, but it has been proved that this is unnecessary. The musk can be reached

through an orifice in the body without killing the deer, and if the animal could be trapped and kept in captivity, using the methods employed on the civet as a model, perhaps the slaughter would be avoided. This is a matter of some significance, because the entire species is threatened with extinction, in spite of the fact that trapping is prohibited in certain parts of Asia.

The method of killing the deer is of more than passing interest. Since the animal is fast on foot, the use of dogs would be impossible. The deer can be trapped en masse, being driven into a large prepared snare, where they are easily shot. Or they can be trapped individually, by snares placed in their usual paths. Or they can be shot by the huntsman, a difficult proposition because the animals inhabit high mountainous regions that do not lend themselves to hunting. The animals have sharp ears, and the least noise makes it possible for the hunter to lose his quarry. But the deer has been endowed by nature with a keen sense of melody, a love for harmony, and the hunter, taking out his flute, suddenly breaks the stillness with stirring music. The musically inclined deer comes closer to the spot from which the melody is emanating, and this proves his undoing.

The perfume material coming from the musk deer is sold under a variety of names, the best known being "musk tonquin." Of all the animal products, most, though not all, perfumers would say that this has the characteristic "animal note" to the greatest extent. It is a very powerful odorant, being detectable in extremely minute quantities, and was

described by early writers as being "ambrosial." As a fixative it is among the best in the realm of perfumery, truly one of the creations of nature that is indispensable in the making of a fine perfume.

Musk tonquin contains approximately 1 to 2 per cent of a cyclic ketone called "muscone," of intense odor, an optically active substance whose racemic form has been duplicated synthetically. The synthetic product, however, cannot replace Asiatic musk because it has been obtained in a small yield, by a difficult series of expensive steps, a chemical achievement of the first order but with no immediate practicable applications.

As anyone versed in perfumery would expect, these animal materials have found usage in the field of flavors, closely allied as they are to perfumes. Musk tonquin is used with some frequency in a maple flavor, and is mentioned in raspberry formulas. Castoreum is used in raspberry, rum, claret wine, and similar notes, but can be said to "round out" or "give a lift" to the flavor, rather than make a specific contribution to the taste. Tincture of civet is found in many formulas, among which we might mention currant, grape, maraschino, pear, strawberry, apple, and raspberry.

As a perfume raw material, ambergris is in a class of its own. In the motley group of animal products none is more legendary, none more valuable. None is better known to the public, none less used by the perfumer. Ambergris has been the subject of seafaring tales and cursing captains' daydreams.

Ambergris is a substance developed by the whale, and most authorities believe that only the male of the species can give it forth. Many theories have been expounded as to why certain whales produce this valuable material. The theory generally accepted is that the whale has a liking for squid (every fisherman has used squid for bait), but the beaks of the squid are indigestible, they irritate the stomach of the whale, and the ill animal forms this substance, known as a "calculus," which it can excrete or which may remain inside the whale and eventually cause its death.

The exuded material is lighter than water and will therefore float. It has a low melting point, but not low enough to cause any disintegration in the hot sun. In fact, the very best ambergris is considered that which has been floating for years before it is finally discovered.

Ambergris is found in large lumps, worth fabulous sums, or occasionally in somewhat smaller but nevertheless valuable pieces. One single lump is reported to have weighed over 300 pounds, and another almost 200.

The test for true ambergris is extremely difficult and in the long run becomes a matter for the perfumer rather than the chemist, though solubility and other analytical tests are helpful. Many lumps of sea matter have been found that somewhat resembled ambergris but were rejected by perfumers, and subsequent microscopic analyses have shown that they were not genuine.

For the chemist, ambergris remains one of the great mysteries of perfumery. Work on its analysis has always been hindered by its high price and its uneven and unpre-

dictable availability. But what little work has been done has failed to give any clue as to the odoriferous principle. No one has even isolated such a substance, much less analyzed or duplicated it.

Like the other animal products, ambergris, too, is a fixative of great value; it is long lasting and mellowing. It is used in small quantities, in the form of an extract, and its odor has been described as akin to that of labdanum. But this description is inadequate. If the comparison, for the perfumer, is poor, it is necessary because no one has suggested a better one.

Finally, there is the muskrat, the newest contribution to the field of animal products. Like the beaver, the muskrat is a member of the rodent family; its name on the one hand suggests the musk deer, and on the other, its zoological name, *Ondatra zibethicus*, is suggestive of the civet. It is not unexpected, then, to find that perfumers have made an effort for many decades to obtain something valuable from this little animal.

In fact, it did not require students of perfumery to determine that the muskrat had musk possibilities. In 1612, Captain John Smith wrote, in *A Map of Verginia, with a Description of the Countrey, the Commodities, People, Government and Religion:*

> Mussacus (muskrat) is a beast of the forme and nature of our water Rats but many of them smell exceedingly strong of muske.

In the middle of the seventeenth century, Father LeJeune wrote in his diary about this animal:

> It is called Musk Rat because, in fact, a part of its body smells of musk, if caught in the Spring—at other times, it has no odor.

And a few years later the same author again had occasion to discuss the odor of the muskrat:

> There are found in these regions of America, animals to which the French have given the name of Muskrat, because in truth they resemble the rats of France—except that they are much larger—and smell of musk in the Spring. The French are very fond of this odor; the Savages dislike it as if it were a stench.

As long ago as April, 1882, we find R. S. Cristiani, in a communication to the editor of *The Soap Makers' Journal* (New York), recommending to his industry American musk from the muskrat, "the well-known rodent, native of this country, and found in nearly all parts of it, frequenting the streams and marshes, and having habits similar to the beaver." In most books on perfumery, authors have found the muskrat worth mentioning, but could see no great value in anything obtained from their glands.

And no wonder. For though a musklike substance was obtained from the glands of the muskrat, it had only a faint odor and little perfume value. It remained for two chemists, Philip G. Stevens of Yale University and J. L. E. Erickson of Louisiana State University, to increase the odor value

some fiftyfold by finding that about 90 per cent of the unsaponifiable material in the glands consisted of large cyclic alcohols which are almost odorless and which they established could be oxidized quantitatively to the corresponding ketones, which have the characteristic musk odor.

Chemically, the muskrat product, which is today marketed under the name of Musc Zibata, contains principally two compounds known by the names of "cyclopentadecanone" and "cycloheptadecanone." These long words are really quite simple. They mean that we have two saturated cyclic ketones, containing fifteen carbon atoms (pentadeca) and seventeen (heptadeca) respectively. Considering that musk tonquin owes its odor to a methyl cyclopentadecanone, and that civet is indebted for its characteristic smell to cycloheptadecenone, we can see how closely related these other natural products are to Musc Zibata.

The muskrat is trapped in marshlands in many parts of the United States, but Louisiana has some 50 per cent of the little animals. The scent glands are found in both male and female; in the latter the gland is so tiny that it is practically worthless. The animal has to be killed to obtain these glands, and then ten ounces of a crude fatty material can be obtained from almost one thousand glands. The ten ounces of the crude yield about three ounces of a neutral musk oil, which is converted into one ounce of Musc Zibata.

That a new natural musk product should have appeared on the scene during the war, amidst the dearth of perfume materials and the flood of orders and demands, is indeed

fortunate. It is still too early to say much about the use of Musc Zibata, except that in the years to come it will surely find its way into the finest perfumes. Its odor is powerful, lasting, musky, somewhat finer and less animallike than musk tonquin. Its fixative value is equal in all respects to the tonquin product, and it serves to round out perfume compositions, blending with odor mixtures of all types. Tests show that it can be used either as a replacement for musk tonquin or as an addition product, to improve and exalt the quality of the Asiatic musk.

History and experience will indicate the important niche that Musc Zibata will occupy in the science and art of perfumery. But none will deny that the perfumer's zoo, that small and exclusive animal club, now has another very important member. And seldom in the history of science is there an example of man's magical transformation of the ugly to the beautiful such as is found in the use of animal scents in perfumes.

CHAPTER

Sticky Stuff, and Fragrant, Too

Sabean odours from the spicy shore
Of Araby the Blest.

JOHN MILTON

It might now seem that our story of natural perfume materials would be complete, including as it does the essential oils, the flower oils, and the various animal secretions. Omitted are only one group, more important historically than industrially—the gums and resins found in trees and plants.

"Tree exudances," as the botanist calls these sticky sap-like substances, play a role in our lives that affects more than perfumes. They include the millions of pounds of chicle, which, when sweetened and flavored, becomes chewing gum, and all the vital natural rubber.

"Resins," "gums," "balsams," "oleoresins," and "resinoids" are words the perfumer is constantly encountering, and yet they are not easy to define. The boundaries between these groups are hardly discernible. All trees contain some resinous materials. The simple manner of getting this material out of the tree, merely by making an incision and collecting it as it flows, would explain why the ancients

discovered these substances long before they were using the more fragrant oils from flowers.

A list of the resins found on the perfumer's shelf includes, among others, olibanum, opopanax, storax, balsam, benzoin, and the almost mythical myrrh. The resinoids, tinctures, and infusions obtained are overshadowed by essential oils in odor value and in the volume consumed, but like the animal substances, these resins show remarkable fixative qualities.

The balsams number at least three that are well known and are commonly called balsams, a fourth that is classified with the others, but does not use that name, and many others that have attracted the attention of investigators but have reached no commercial success.

Balsam Peru, tolu, copaiba, and the associated substance, storax, are all very viscous, highly colored liquids, obtained directly from the trees. The balsams are not oils. They do contain an essential oil that can be isolated from the thick and sticky substances. The term, "balsam," closely connected with the word, "balm," denotes the in-between products, less hard and brittle than the so-called "hard resins," and more so than the gum resins.

South America excels in the production of the balsams, as at one time it did in rubber. Balsam Peru, the very best of which comes not from Peru but from San Salvador, oozes from the wood and is absorbed by cloths that have been placed on the trees. The rags become saturated with the sticky liquid. They are then thrown into cans and boiled until the balsam separates from the cloths. Purification

consists primarily in allowing the balsam to stand for a week or two, during which time the impurities settle at the bottom.

Balsam tolu, likewise a South American product, derives its name from the botanical term "Toluiferum," from which species it comes. It is obtained in a manner not unlike the Peru, but hardens more quickly. Also from South America is balsam copaiba, a mixture from several botanically related South American trees, and at one time of interest to medicine.

From one of the earliest centers of commerce in perfume materials, Asia Minor, comes storax. It does not flow from a tree but must be extracted from the bark with warm water. The storax balsam melts, separates from the bark, and goes into the water. The warm and wet bark is expressed, and the oil obtained is added to the balsam. The combination is known as "liquid storax," a substance of importance and interest to modern perfumery. It is a grayish, sticky material, with a romantic history dating back to ancient Greece and the Holy Scriptures.

All of these balsams have in common not only a similar consistency, but a similarity in odor, something refreshing and akin to vanilla about their fragrance.

Of the hard resins of use to the perfumer, only benzoin is renowned. It was one of the earliest of incense materials and came from such romantic-sounding spots on earth as Sumatra, Penang, and Palembang, as well as from its chief source, the land of Siam, today known as Thailand.

In literature many centuries old, this substance was called

"incense of Java," the words for which, in the native tongue, were *Luban Jawi*. The first syllable was dropped and one word made out of two, "banjawi," which developed through several minute linguistic changes to "benjui," "benzoi," "benzoin," and "benjamin." Later, in the development of organic chemistry, an acid was isolated from this resin and was given the logical name of "benzoic acid." Thus the ancient incense material, *Luban Jawi*, determined the nomenclature for benzene, benzaldehyde, benzoic acid, and innumerable organic derivatives, and today benzoin assumes an importance in its influence on the language of chemistry all out of proportion to its significance in science or in industry.

Like storax and the balsams, benzoin has a strong vanilla-like fragrance, as would be expected from the vanillin that is found in it.

Benzoin does not exist in a normal healthy tree, but incisions and wounds cause the tree to produce the substance, which flows out of the opening. If the bark is loosened, the benzoin can roll down and harden on the inside of the bark; if incisions are cut, generally of a V shape, it will roll down to the bottom of the V and there be collected.

One of the benzoin forms is known by the colorful term of "benzoin tears." After the benzoin has oozed out of the trees, it can take one of several forms. It can be long and loose, the tears; or a waxy mass, the amygdaloid; or a ground mass, the lumps.

The softest of the resinous materials used by the perfumer are the gums, of which typical members are myrrh, lab-

danum, and galbanum. Labdanum, the most important of these, is a sticky exudance that comes from the leaves of a plant thriving on Crete, Cyprus, Greece, southern France, and Spain. The leaves are raked up and the labdanum is scraped off with a knife; or the branches are boiled up with water, a method employed in Spain. The material can also be extracted from the leaves with volatile solvents, a system used in France today.

Purification yields a dark, sticky material, from which there can be extracted a substance which is sold on the market as "ambrein," having an odor suggestive of ambergris, and of extreme fixative value.

How is it possible for a modern perfumer to handle materials that are hard and brittle, or sticky as ordinary gum? The answer is that it is not possible, and for that reason derivatives must be made. In the latter part of the nineteenth century the perfumers began to experiment to make these materials more pliable, more facile for handling, to make use of their fixative properties while avoiding their heavy discoloring effects.

By washing the resins or gums with benzene or alcohol, as the case may be, the most difficultly soluble materials are removed, and then, upon evaporation of the solvent, there remains a somewhat less viscous, still valuable, more easily usable substance called a "resinoid."

Even the resinoids would not be ideal for a perfumer to use. The resins, gums, balsams, and animal fixatives are therefore made up in a solution, which can range widely in strength, being as weak as two ounces to a gallon of solvent,

or as strong as four pounds to a gallon. If the application of heat is necessary to bring the resins into solution, the substance derived is known as an "infusion"; when prepared in the cold, it is called a "tincture." Among the solvents used in the preparation of infusions and tinctures are benzyl benzoate, diethyl phthalate, as well as alcohol.

The tinctures or infusions are aged by careful, patient processes, usually in cool and dark places, by methods of which a great deal is known within the trade and passed down by word of mouth, but little of which ever sees the light of print.

The aged tinctures are clear and mellow, have a powerful odor that comes through the alcohol, and can be used in minute quantities. They have on the finished perfume the magical and largely inexplicable effect of retarding its evaporation.

It must have been of substances like these that Edgar Allan Poe was dreaming when he yelled, half crazed, at the raven:

> . . . tell me truly, I implore,—
> Is there—is there balm in Gilead?—tell me—
> tell me, I implore!

CHAPTER 7

Man the Duplicator

To throw a perfume on the violet . . .
Is wasteful and ridiculous excess.

WILLIAM SHAKESPEARE

FROM the dawn of perfumery until the middle of the nineteenth century the blender of fragrant scents had a wide variety of tools, limited entirely, however, to the creations of nature. Oils, gums, resins, absolutes, washings, animal products—all dated back many centuries.

The art made advances. New oils were found and improved methods for their production developed. New artistic blends were created. The possibilities of alcohol in perfumery were discovered and exploited. But no revolutionary changes in the science of creating odors can be recorded from the days of Cleopatra to the days of Napoleon.

In the beginning of the development of the modern science of chemistry, it was firmly believed that all chemicals found in plant and animal life, in blood and bone and tissue, and—yes, essential oils—had some vaguely defined, rather mystical "vital force." These chemicals were like living things, and it was no more possible, the scientists up to the nineteenth century contended, to create a living

chemical like sugar in a laboratory than to create a living animal in a test tube.

All chemicals were divided into two great classes: the mineral substances, the stuff of earth, its metals and salts, known as the inorganic; and the materials of life, the organic.

In 1828, Friedrich Wohler, professor of chemistry at an obscure Berlin school, stepped forth with the courage of a frontiersman and announced to an astonished and skeptical world of science that he had created urea in his laboratory. Urea, as the name suggests, is a substance produced in animal bodies and found in urine. The twenty-eight-year-old German chemist had made it from the so-called "inorganic substance," ammonium cyanate.

The work of Wohler, to whom we trace the birth of organic synthesis, was disputed by many of his foremost colleagues. Wohler himself wrote to his Swedish contemporary, Berzelius, a man of no mean stature in the science, "I must tell you that I can prepare urea without requiring a kidney or an animal, either man or dog."

The theory of vital force had been refuted, but the term "organic chemistry" was here to stay. Like so many scientific misnomers, it was a useful appellation. It came to be applied to the science of chemicals containing carbon. It had been noted that all the chemicals found in living organisms had a characteristic in common: they all contained the element carbon.

Were it not for the fact that the chemistry of the carbon compounds is so different from that of mineral substances,

the name would have lost its significance. But organic chemistry involves matters of classification, analysis, structure, synthesis, physical and chemical characteristics, and uses so different from the inorganic that its study constitutes a separate science.

The first effort to introduce a synthetic to the field of perfumery was short-lived, and important only historically. The chemical was called "nitrobenzene," also known as "oil of mirbane." It was easy and inexpensive to make, prepared by the simple reaction of nitric acid and benzene, two cheap and readily available materials. It had an odor not unlike that of bitter-almond oil, but much more coarse, less sweet and pleasant, and could hardly be considered a replacement for the genuine oil. It was too toxic for flavors and too readily absorbed by the skin for perfumes. Nitrobenzene was an inauspicious beginning for synthetics, but a beginning it was. Today no self-respecting perfumery formula would be found with nitrobenzene in its company!

As this field of organic chemistry began to unfold in all its glory, it held forth great possibilities for the creators of odors. If urea could be synthesized, and oxalic acid, indigo, aniline, and a host of other valuable substances, then why not the precious ingredients that give odor and flavor to the essential oils?

The problem was not a simple one. The first step was to obtain the chemical, in a pure state, from the oil. This process is called "isolation." In other words, the substance of greatest value in the oil must be isolated from all the

other chemicals with which it is in such intimate association. There are various methods to approach this problem of isolation, and the chemist must usually make use of many of them. Some substances can be separated from each other by distillation, because of their variations in boiling points. Steam distillation is useful in separating the substances that tend to distill with the water vapors from those that do not. Treatment with oxidizing agents and many other chemical reagents may result in the formation of some solid derivatives, which can then be filtered off; or it may result in the formation of two or more layers, not miscible in each other, and easily separable. Treatment with carefully selected solvents may result in part of the oil going into solution, thus separating it from the insoluble section. By cooling the oil to very low temperatures, some substances will crystallize or solidify, and they are then removable. By subjecting the oil to one or several such methods, it is often possible to separate one or more pure substances.

The task is not a difficult one—if someone has done it before, and the chemist is merely following directions. But given a new oil never before investigated, and knowing nothing about the chemistry of the most valuable ingredient, the odoriferous principle, the exploratory groundwork is arduous though fascinating work.

A number of such odoriferous principles had been isolated. There was vanillin from the vanilla bean, and coumarin from the tonka bean. But isolation, followed by purification, is only the first step. The chemist must then

determine the stuff of which the chemical is made. He must build up the structure of the molecule.

This molecule is the smallest unit of any chemical compound. It is invisible under the most powerful of microscopes. It is so small in size, so insignificant in weight, that its dimensions are hardly conceivable to a human mind. If we take a gram (which is about one-twenty-eighth of an ounce) of a substance, and divide it into one hundred million parts, then each of these minute sections still contains millions of molecules.

If we could take one cubic centimeter of water (which is the equivalent of several drops) and remove the molecules at the rate of one million a second, it would take a billion years to remove all of them. Or, if each molecule in one quart of water were as large as that quart itself, that bit of water would be as great as the volume of our entire planet.

Not an easy building block to visualize. But the chemist must determine not only how many parts of carbon, hydrogen, oxygen, and other elements are in the molecule, but just how they are arranged in relation to each other.

Having found the percentage of each element, the chemist can construct what he calls an "empirical formula," which indicates that for every atom of oxygen there may be, for example, fifteen of hydrogen and ten of carbon, as the case may be. By a molecular weight determination, which demonstrates the relative weight of any given number of molecules as expressed in relation to oxygen, the standard, he obtains his molecular formula. In the case of vanillin, this would read $C_8H_8O_3$, which simply states that there

are eight atoms of carbon, eight of hydrogen, and three of oxygen comprising one vanillin molecule.

It is a long stretch from knowing a molecular formula to unraveling the architecture of the compound. What a difference it makes how these atoms are connected with each other! Take a simple formula like C_2H_6O. One arrangement of the atoms gives the intoxicant, ethyl alcohol, and the other a gas, dimethyl ether. These substances that have the same number of atoms of each element in the molecule, but a different arrangement, are known as "isomers." As chemical compounds they frequently have very little, if anything, in common.

It would seem to be impossible to discover the arrangement of the things one cannot see. But brilliant research, particularly during the last century and a half, aided by minds gifted in the realm of logic and deduction, have built up on firm foundations a science of analytical methods.

It is found, for instance, that alcohols react with sodium but aldehydes and most ketones do not. Potassium permanganate is a reagent employed as a test for unsaturation, or the double bond; another reagent tests for aldehydes. Compounds are treated with a host of chemical reagents that give specific reactions and characteristic degradation products, and if the resulting product (or products) is a readily identifiable substance, conclusions can be drawn as to the probable structure of the starting material.

This would be fine, if only each one of these chemicals did not act peculiarly at one time or another. If these tests and reactions are the building blocks in working out the

structure, the numerous exceptions are the stumbling blocks. No test is foolproof, and no chemical is ideal.

And what has the chemist, finally? He has a model that he sets out to duplicate.

The first major contribution in the history of synthetic perfumery was made by the brilliant young British chemist, William Henry Perkin. This was the Perkin who, at the age of eighteen, had set out to build up the complex quinine molecule, a work that though it did not lead to its goal brought young Perkin directly on the path to the first dyestuff made from coal tar, aniline purple.

The youthful chemist followed this discovery with other brilliant successes, and his first synthesis of coumarin revolutionized the concepts of perfume chemistry.

Coumarin is generally described as having the odor of new-mown hay. It is a rather sweetish substance, a flavoring favorite, found in the tonka bean, in lavender oil, and elsewhere.

When and by whom it was first isolated and identified is a matter of conjecture; one history traces its identification back to 1813. It was not a molecule of simple structure, this coumarin that Perkin tackled, but it did not stump him. His mind was as imaginative as it was scientific. His chemistry departed radically from all the known procedures for molecule building. His success was hard earned and well deserved.

Perkin's synthesis consisted of taking salicylic aldehyde, a derivative of one of the coal-tar substances, phenol or orthocresol, and reacting it with sodium acetate and acetic

anhydride. The coumarin that he obtained was in every respect identical with that in living plants. Here was a synthetic, not only as fine as nature's own, but different in no respect from the natural coumarin. This was man, the duplicator, in his supreme achievement.

And if the tonka bean's coumarin could be made in Perkin's laboratory, why not a hundred other valuable molecules responsible for the exquisite odor of flowers and the pleasant taste of spices?

The years that followed brought a richness of chemical invention that laid the basis for modern perfumery. Throughout western Europe university professors and scientists in industry set their minds to making synthetic odors and flavors. One of the most fertile minds to tackle the job was a professor at the University of Berlin, Ferdinand Tiemann. In 1876 he built up the then priceless vanillin, the sweet substance used in chocolate bars, biscuits, and confections of all kinds today. There is vanillin these days in the best perfumes and in a penny piece of candy, but the first year that the synthetic vanillin was placed on the market, prices were paid ranging from $250 to $800 per pound.

In the synthesis of vanillin, Tiemann used pine wood as his starting material, from which he obtained coniferin, a combination of a sugar and an alcohol. In the years that followed, new and more economical processes were worked out. For a long time the leading raw material was eugenol, which is found in clove oil. Another synthesis of interest consisted in preparing vanillin from the simple substance,

benzene. And, completing the cycle that started with Tiemann's synthesis, chemists are today back to the forests for their vanillin; they are using lignin, found in the waste liquors of the paper-pulp factories.

What did these developments mean to the consumer? While the price index of commodities in general was rising during the past seventy years, the cost of vanillin went steadily downward. Gone are the days when the dealer in aromatics would open up his safe at night and remove other valuables to make room for a few pounds of vanillin. This would hardly be worth while, with a price of about $3 a pound for a chemical more pure, more free of by-odors and alien tastes, than any Tiemann ever dreamed of making.

Add to coumarin and vanillin a long list of other odorous materials that the chemists were making in Europe at about that time. There was indole, the ill-smelling substance found in jasmin, that perfumers use in small quantities with most unexpected results. Its synthesis was the achievement of Baeyer, whom history also credits with the synthesis of the well-known dye, indigo. Add heliotropin, found in several of the lesser known oils, and created synthetically. And then, in 1887, there was accomplished the first commercial production of the indispensable ingredient of every lilac perfume, terpineol. And by this time we have the creation of a group of substances destined to change the economic and artistic picture of the perfume world.

For these and the other duplications of the chemicals found in essential oils the scientists had gone to a wide variety of raw materials. In some cases they were using the

essential oils themselves as their sources and then chemically transforming the isolated material into a new chemical. Such was the case with heliotropin, with its delicate and long-lasting odor of the heliotrope. The chemists build up this aromatic substance from safrole, found in camphor oil and sassafras oil. In other cases the derivatives of the coal mine were man's starting tools; this was so in the synthesis of phenyl ethyl alcohol, placed by nature in rose oil, as its odor would immediately indicate.

It remained for the chemists to take the complicated chemical substances found in essential oils in such abundance, the terpenes and their oxygenated derivatives, and work out a complete structure, starting from simple and readily available chemicals. This would mean synthetic geraniol, rhodinol, citral, terpineol, not starting from pine oil or lemon oil, but from the derivatives of "coal, water and air," as the makers of nylon have been so fond of saying.

Historically, many chemists had a hand in this task, but three of them made outstanding contributions. First there was Merling, with his synthesis of isoprene, starting from acetone, which he took through a series of classical but difficult steps. In 1901, Ipatieff, working with isoprene, built up methyl heptenone, compound of the terpene series, found in lemongrass and other oils. And in 1919 the great Swiss chemist, Ruzicka, treating methyl heptenone with acetylene, obtained a chemical which, on reduction, was linaloöl.

Here was linaloöl, and after that, what? Was this the end of the trail? Was synthetic aromatic chemistry going to

replace some of the essential oils, bergamot and rosewood and geranium, as sources for the beginnings of chemical synthesis? Would the industry bringing forth these oils drop by the wayside, a victim of technological advance?

Only the crystal-gazer would answer that question, and if he might be tempted to nod affirmatively, he would quickly modify himself with the remark that we are far, very far, from that goal. Even in wartime, when the dearth of oils left the market bare, and with consumers ready to pay exorbitant prices, no one gave serious thought to a synthetic linaloöl. The intermediate stages are many, the yields none too good, and the final price prohibitive. Synthetic linaloöl remains a laboratory curiosity, a great piece of chemical architecture, with no immediate practicable application.

But long before Ruzicka announced his synthesis of linaloöl, another development of significance had occurred. In this molecule building, chemists had stumbled—at first quite by accident—on new substances, unknown in the realm of natural history, with odors as rare and as fine as anything in the vegetable or animal kingdom. There were new molecules that smelled like old ones; and others, as pleasant as they were intriguing, that smelled like nothing ever passed under the nose of man before. Indeed, the possibilities were limitless!

CHAPTER 8

Man the Creator

No man can learn what he has not preparation for learning, however near to his eyes is the object. A chemist may tell his most precious secrets to a carpenter, and he shall be never the wiser—the secrets he would not utter to a chemist for an estate. . . . Our eyes are holden that we cannot see things that stare us in the face, until the hour arrives when the mind is ripened; then we behold, and the time when we saw them not is like a dream.

RALPH WALDO EMERSON

THE greatest achievements in the realm of science have been crowned by success through a combination of brilliance, patience, and perseverance, to which we may add the fortunate quirks of fate that have aided the hands of the most gifted. Seldom in history have so many unexpected factors combined to yield a result so gratifying to man as in the invention of the chemicals known as the "ionones."

It was the same Ferdinand Tiemann whose achievements in vanillin had won him well-deserved recognition who turned his attention in the early 1890's to the quest for the chemical that produced the violet odor in the flower of that name.

It would be natural to expect the professor to use for his studies the oil of violet, but this oil was a luxury few could afford. It takes 33,000 pounds of violet leaves to yield a pound of the oil, and it takes 2,000 flowers to give this pound of leaves. That the oil sold for several thousand dollars a pound was not surprising, and without the modern methods of microchemistry, which handles chemicals in minute quantities, the experiments of Tiemann and his colleagues could well consume 5 or 10 pounds.

How fortunate that this scientist did not have access to the material he so ardently desired! For he turned his attention to orris root, whose odor resembled that of the violet sufficiently to warrant his conclusion that the same chemical was responsible for the fragrance of the two plants.

From orris root (the plant is also known as "iris"), Tiemann isolated a ketone, which he named "irone," and which had the definite violet character he was seeking. He set to work to pull the unknown molecule apart and soon had a formula that—fortunately—was all wrong. He had only thirteen carbons in his irone molecule, instead of the fourteen now found there; and he had a structural arrangement that has since been discarded. And this incorrect drawing of the irone structure was Tiemann's second piece of good luck.

Having before him an incorrect formula, Tiemann and his chief coworker, Paul Kruger, proceeded to build up the new chemical compound. They took citral, the aldehyde found in Indian lemongrass oil, and thought that they could condense it with acetone, split off water, and have

irone. It was a planned society of atoms that these architects of chemistry were constructing, and with all their errors, their work is resplendent in its profundity and its logic.

But the careful condensation gave no irone, nor did it result even in a pleasant violet-scented odor. And it looked as if the trail of Kruger and Tiemann would lead to no success.

Chemistry has its mythology, built around the lives and works of the great, and at this point there is told a story that may have to be accepted with a grain of salt. It is said that Tiemann was discouraged. He picked up a beaker in which some of this newly created but almost odorless chemical had been standing and gave the glassware to a laboratory assistant to be cleaned out. The young man poured some strong mineral acids into the beaker and the fragrance of the violet arose from the glass.

Whether this transformation from pseudo-ionone to ionone was planned, was the romantic fantasy of an imaginative mind, or was purely accidental—one more link in a happy chain of coincidences—is today of little interest. Whatever the cause, these chemists had made ionone. It was not irone, nor was it even the substance they wrongly thought irone to be.

Here was a synthetic, entirely unknown in natural history. Man, the creator, truly a competitor with nature. What further proof that the realm of essential oils would not exhaust the possibilities for finding new and undreamed-of odorous substances?

The "ionones," as this new group were to be called, were

really a mixture of two chemicals, differing only in a slight structural change. Following the invention, there were perfected means of separating ionone into the two isomers, known as "alpha" and "beta."

After ionone had been synthesized, chemists substituted other methyl ketones for acetone and were able to create a methyl ionone, the best known of the related substances, and allyl ionone, of Swiss origin, among others.

In 1893, the year of the Tiemann-Kruger patent, ionone was offered at well over $500 a pound. Fifty years later it was being sold in America for $10 and less, in grades far superior, more pure, more free of the odors of the raw materials than the exorbitantly priced chemical of yesteryear.

Ionone was greeted for a moment with some hesitation. The prejudice against synthetic chemicals in perfumery was still very strong. But soon its fame spread far and wide. It was acclaimed wherever fine perfumes were being made, and it began to appear, in larger or smaller proportions, in finished high-class perfumes of all types.

By 1893 this new creative synthesis of perfume chemicals was achieving success in another field, closely related to explosives. It had been observed for many years that the valuable and powerful odor of musk could be generated by creating chemicals with either two or three nitro groups in the hexagon known as the "benzene ring."

When three such groups, each one of which is made up of one atom of nitrogen and two of oxygen, are in the ring, and when the parent coal-tar substance is toluene, we have trinitrotoluene, known as TNT. That TNT and perfumes

are chemical first cousins was one of the great discoveries of the European chemists toward the close of the last century.

The relationship between nitrogen-bearing compounds and musky odors was observed in the days when chemistry was still trying to throw off the cloak of the alchemist. Away back in 1759, a certain Margraf recorded that he had treated the resinous oil of amber with nitric acid and had obtained something that he called "artificial musk."

More than a century passed before this was followed up by a synthesis that held out some promise for a new musk. In 1881 Werner Kelbe described a chemical of a musky odor, differing from TNT only in the presence of an isopropyl group in the molecule.

On July 3, 1888, the German patent office awarded a patent to Albert Baur of Gispersleben for a synthetic musk known as Musk Baur, which he also called Musk B or Tonquinol. Musk Baur, placed on the market for $300 a pound, was not difficult to sell, for the musk odor had hitherto been confined to the expensive natural animal products.

As frequently occurs in scientific history, many investigators were working in different places along similar lines. So that the year that brought Musk Baur on the market also saw the debut of musk xylene, the invention of Schnaufer and Hupfeld, and the first of these new synthetics to survive the test of time.

By the turn of the century, there had been developed hundreds of variants. The six points in the benzene ring

offered almost limitless possibilities for arrangements and substitutions to make nitrated compounds.

Musk Baur has fallen by the wayside, but its inventor was responsible for two of the musks still made to this day, the ambrette and the ketone. Add to this the already mentioned xylene, and the comparatively recent Moskene from Switzerland, and America's contribution, Musk Tibetine, and we have five powerful substances, of which a minute quantity will go far in the development and stabilization of a perfume.

The musks, superior in every way to Baur's $300-a-pound product, are today made at prices ranging from $2 to $10. They are as important on a perfumer's shelf as any oil from a plant or flower.

After the synthetic musks and the ionones, came the golden age of synthetic organic chemistry, when each year brought new developments of outstanding and lasting import.

There was the great contribution of Professor Blanc, working in his university laboratory, who called his new chemical "cyclamen aldehyde," as round a floral note as can be found in any bottle, and as true to the odor of cyclamen flower as if it were an extract.

There were all sorts of chemical modifications of the materials found in essential oils. One of the most interesting results was hydroxycitronellal, itself having a lily-of-the-valley or linden odor, but today placed by perfumers into a lilac, jasmin, or for that matter in almost every perfume formulation.

There was the work of Walbaum, Ruzicka, and others, who followed the synthesis of muscone and civetone by building new musk products of structure closely related to these natural substances. Two such materials that have received commercial acceptance are Exaltone and Astrotone; though still high in price, they are among the outstanding achievements of synthetic aromatic chemistry.

The end is not in sight. But one oft-repeated statement bears reiteration. The synthetics are the precious, indispensable complement of the natural oils. For some purposes they have no equals among the oils. For other notes they are usable only with the naturals, while still others are almost indistinguishable from the flower odors, except that the synthetic is usually more pure, more true to the plant, than the oil itself.

There is no perfume of any value today that could be made without synthetic aromatic chemicals. Banish the artificial musks, hydroxycitronellal, ionone and its homologues, the synthetic coumarin, vanillin and benzaldehyde, phenyl ethyl alcohol, and a host of others, and you will not only have upset the entire economic structure upon which the cost of the perfume is based, you will have an artist painting in oils with his red and blue but without any yellow.

Synthetics have made the greatest contribution to this science since the discovery of alcohol, one perfume historian wrote, and surely this is no exaggeration. Ionone is as vital in its own way as jasmin; the finished perfume without synthetics is unthinkable, just as the finished fragrance without naturals is undesirable.

Nor is the natural-containing perfume the more lasting. There are odors that are more durable than others. Some substances that contribute to this durability are naturals, and others synthetics.

It is part of man's inferiority complex, or perhaps his scientific conservatism, that he cannot conceive of the product in the beaker as being as precious as the product in the flower. Perhaps it is a snobbery, born of a love of something that costs $100 an ounce. But if a section of the unenlightened perfume-consuming public is still to be convinced, this skepticism is unshared by any perfumer.

To return to Tiemann and Kruger and their ionone. To the ionones, as to the synthetic musks, we trace the beginnings of the development of aromatics not found in natural products. These are perfume chemicals unknown in the world of nature. Unknown? Yes, and no. More than three decades after the synthesis of ionone, an Australian scientist by the name of Penfold was investigating the oil obtained from the brown boronia. He separated it into a number of components, one of which he held to his nose, and to his astonishment it had the exact fragrance of beta-ionone. Surely this was a mistake. Penfold proceeded to make his tests, which would determine whether or not this was ionone. He formed a solid derivative, which is known as a "semicarbazone," and took the melting point, which was practically identical with the melting point of the same derivative of synthetic beta-ionone. The next step would demonstrate whether these were the same or different substances. He mixed the derivatives of the natural and syn-

thetic chemicals; if they were different chemicals, the melting point would go down. He knew the significance of his work, carefully watched the results, and found that in the boronia plant he had discovered beta-ionone. The results of Penfold were confirmed by French chemists.

It is an interesting sidelight on the work of Tiemann and Kruger that this beta-ionone is today beginning to come in for scrutiny more careful than ever before. For vitamin A remains one of the unsolved problems of chemical synthesis, although its structure has been determined beyond any doubt. When the beta-ionone formula is drawn, it is seen that it makes up one part of the formula of vitamin A. Dropping the oxygen atom that in beta-ionone is bound in a form characterizing this substance as a ketone, and continuing the chain of carbon atoms, beta-ionone is transformed—on a scrap of paper—into vitamin A.

It is likely that we shall see a synthesis of this potent substance in our lifetime, and it would not be surprising if beta-ionone were one of the starting materials.

Indeed a strange trail that started when Tiemann and Kruger could not afford to work with oil of violet!

CHAPTER 9

An Artist in a Laboratory

A great nose indicates a very great man—
Genial, courteous, intellectual,
Virile, courageous.

EDMOND ROSTAND

THE professional perfumer is one of the strange anomalies of our civilization. In his laboratory, at one moment he looks like the modern technician, measuring with the greatest accuracy at a sensitive balance, pondering over heavy tomes that disclose the latest scientific findings about his materials. A moment later, he picks up a little perfume blotter and smells, first from one nostril, then from the other, back and forth, over and over again. He walks through long corridors, looking like a man among the clouds, and every so often he raises the blotter to one nostril, then to the other.

He is hard at work, and he may do nothing else for all the morning but smell the blotter, then smell another one, trying to delve into the odor. When he creates, he seeks to blend all varieties of diversified odors into a single one. But when he smells, he seeks to choose all the component parts and smell them separately, and then all together.

His is an art and a science, without a school, without teachers, with textbooks that are, and by their nature must be, woefully inadequate. Unlike the painter or the musician, he would be the first to deny any natural predilections for his art.

The teacher is the laboratory, and the method one of memory, patience, repetition, and association. The perfumer may have a chemical foundation for his art. He will associate with an odor a name and a mental image of a formula.

In his first days and months in the laboratory it seemed incredible that anyone could learn to recognize so many different odors. Gradually they came to him, some with greater effort than others. Later, as a trained perfumer, he could recognize a thousand different smells, relating each one to a different essential oil or aromatic chemical. In addition, he developed an ability to discern whether the odor is true to the pure substance, what quality it is, what synthetic or natural product it came from. He will know the vetivert and will unhesitatingly state whether it came from Réunion or the Dutch East Indies. When he smells ylang ylang, he knows whether it is first, second, or third quality, and whether or not it came from the Philippine Islands. A sniff of vanillin will indicate by what process it has been made.

In one odor he finds a suggestion of another. He makes a mental note that they may be interchangeable, and then develops their points of difference.

The apprentice in the perfume laboratory begins to learn

how to put an odor together. He mixes some terpineol, and then a little cananga and ylang ylang, and knows he is building up a lilac. He is like the artist who adds blue to his purple, and then puts on a dab of yellow, looks at the mixture, touches it ever so slightly with his pink, and knows that there is the shade he was seeking. He looks and knows, though it is hard to say why, just as the perfumer smells, and feels he has arrived at the blend he has in mind.

The perfumer is like the artist, but not quite; for he must be able to make an exact duplication of his creation once it is satisfactory to him. So he measures on his balance and in his graduate, and watches the liquids as they fall into the bottle, constantly smelling, hesitating, debating, continuing, recording the amounts used, then proceeding to the next substance.

The nose of the perfumer is never out of action. He smells each bottle as he takes it off the shelf. Now he has oil of geranium Bourbon. He has sniffed at the bottle a thousand times this year, but as a reflex action he brings it up to his nose again. He finds it physically impossible to open a bottle without smelling it. Sometimes, once in a while, he may detect something wrong. He not only smells the contents from the bottle, but then smells a drop of it on a blotter, and is constantly smelling the mixture as he creates. He is fascinated by the drop-by-drop transformation.

The perfumer is aware of odor fatigue. He feels that his nose is more reliable in the morning than in the afternoon. He is aware of odor corruption, from bodies, bottles, the air itself. To overcome this, he takes his blotters and bottles

into a booth, where the air has been completely deodorized. This is his ivory tower.

Into his perfume he puts the base that will contribute the main note he is seeking to create. If it is a rosy odor, the bases may include such naturals as rose oil and geranium, such isolates as citronellol, derivatives as hydroxycitronellol, and synthetics like phenyl ethyl alcohol.

Or the point of departure may be entirely different. He may start with what the industry calls a specialty. These are neither finished perfumes nor raw materials. They are the aromatic chemical company's equivalents to man-made flower oils. They are blended mixtures, sometimes suggestive of one of the natural odors, more frequently a complete departure, and around the specialty a perfume is built up. They are mixtures that lend themselves in easy harmony with a wide variety of oils and chemicals, and that can be used as a beginning to go in many different directions. These specialties are used in most of our popular perfumes today.

To his background note the perfumer adds his floral bouquet, usually in smaller quantities, to round out and take the conflictions out of his perfume. The bouquet brings the substances together, harmonizing the chemicals and the oils.

Finally, he must add, in small quantities, the powerful fixatives that hold his perfume together against the changes of time. History has taught him which oils and chemicals possess this highly valued fixative quality. To this knowledge he must add an understanding of how to choose the

correct fixative for his own mixture, and in what quantities the fixative will be most effective, without interfering with the odor he is producing.

Natural musk, almost certain not to let the perfumer down as a fixative, can easily destroy the tone of the perfume if not used in carefully selected quantity. Oakmoss, a fixative that makes a definite earthy contribution to the perfume odor, can easily ruin a fine perfume, or cause discoloration, if not used properly.

After the perfume base is completed and it has passed the nose test, the perfumer makes up alcoholic solutions in various strengths. Satisfied with his product, he proceeds to make up a larger quantity.

He follows the formula, multiplying each ingredient by the same figure, to give an exact proportion. The finished base is heated gently, with enough warmth to induce a more homogeneous mixture. He then measures out a quantity of a specially prepared ethyl alcohol, made up for perfumery purposes, containing denaturants that are difficult to remove and in no way affect the odor, but must be present so that the alcohol cannot be diverted into beverage channels.

The proportion of the perfume base to the alcohol is a matter of choice. It can range from about 16 to some 30 ounces of the base to each gallon or 128 ounces, for perfume; with a smaller amount for an eau de Cologne or for a toilet water. It would not be correct to say that the more perfume base, the better the perfume. Heavier odors, Oriental types, strong floral notes like the gardenia cannot be made up in

the same strength as a light and evanescent odor like orange blossom.

The alcohol and base are mixed together, and then placed in a sealed container and put into a refrigerator, where some of the substances insoluble in colder alcohol come out of solution. Following refrigeration, the perfume is removed and immediately filtered through paper sprinkled generously with magnesium carbonate, an aid to catching these tiny impurities. Then it is placed into carefully cleaned and thoroughly dried bottles and put away to be aged.

All this is in the perfume-formulary books. Then why create a new rose formula? First, the book formulations are insufficient. None of the great formulas has ever been disclosed, and none of them, if disclosed, could be followed by the uninitiated. The novice may read: "Linaloöl—3 parts out of 1,000." But each linaloöl has its own characteristic nuances, differing with the individual source in nature and the process of the producer. Knowing this, the perfumer makes his modifications to give the correct end effect. He is as exact as a scientist, as flexible as an artist.

The perfumer, sitting with his feet on his desk and blotter at his nose, who has created this new odor, may or may not be a chemist. Some know little of the science, are unable to unravel the mystery of its nomenclature, are baffled by the long names on labels, yet are able to recognize the chemicals by their smells, and find methods of using them.

Whether or not he is a chemist, he is confronted with chemical problems that cannot be ignored. The ingredients in his perfume may act upon each other to cause chemical

changes. Acetaldehyde, with its somewhat fruity odor, is readily oxidized to acetic acid, with the characteristic smell of vinegar. Any such alteration, no matter how slight, will affect a bouquet. And when the oils and chemicals must remain true to odor for years, as a good perfume should, and when this perfume comes into contact with the air, as is inevitable, the problem is a difficult one.

This is what is known as "stabilization." Chemicals undergo all sorts of reactions, even without the aid of heat. They oxidize, saponify, polymerize. The odors change, and so do the colors and the consistency.

The perfumer finds some ingredients more liable to change than others. He uses them with trepidation, watches their behavior. He finds two ingredients, each stable enough by itself, but unstable in contact with each other. He avoids such undesirable coupling. He finds other ingredients likely to inhibit changes; some substances, present only in the smallest quantities, have stabilizing effects.

He is faced with the problem of the fixative. The various ingredients have different degrees of volatility. In other words, when a bottle is opened and the lady takes a whiff, one chemical may evaporate more easily than another. As time goes on, the original formula will have changed, and the odor changed with it. If there is a mixture of equal volumes of ether and alcohol, with the former evaporating much more readily, we can reach a point where there are five parts of the alcohol for every four parts of ether. The mixture no longer smells quite the same.

The fixative binds all the ingredients together. It brings

them into an indissoluble unity. They leave the bottle as one smell, and remain behind in constant proportions. No chemical, oil, or resin does this to perfection, but many show a marked tendency for fixative values.

Finally, the perfumer must be constantly aware of the end use of his perfume. A perfume base created for a toilet water may not be compatible with the ingredients of a lipstick, may not blend well with creams, may discolor white soap.

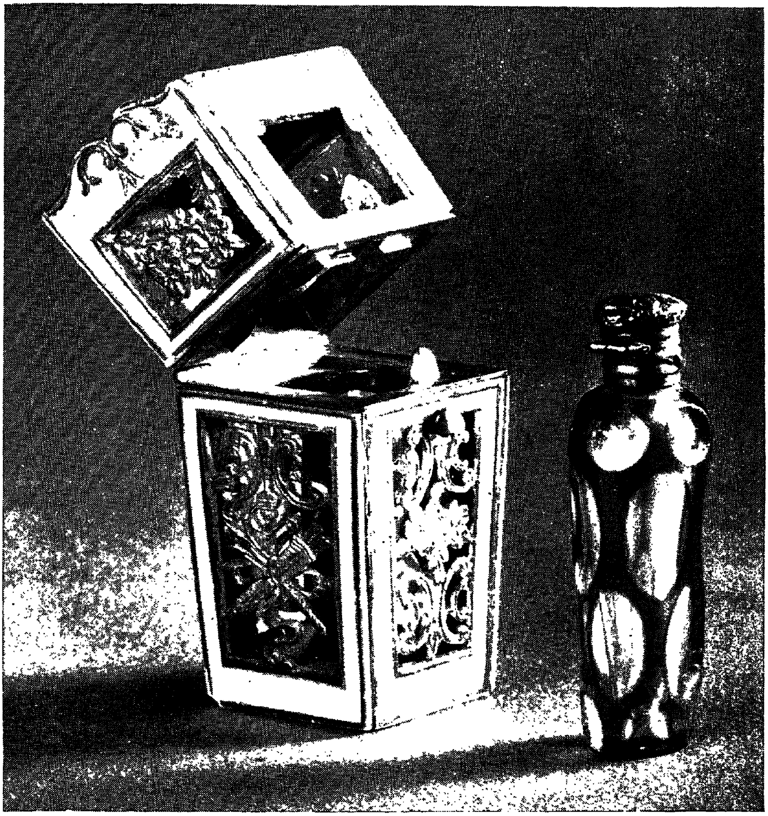
In and around the perfume laboratory, he has the equipment for the creation of every type of cosmetic. There is elaborate apparatus for making soap; molds for lipsticks; jars, vials, bottles; and machinery for creams, ointments, sun-tan lotions, and cosmetic stockings.

Creation is the perfumer's supreme artistry, but duplication is a vital part of his business. There are flowers whose odors must be created in the laboratory. There are oils themselves, not available at one time or another, which are to be artificially simulated.

For a special purpose the perfumer may have to reproduce faithfully the odor of fresh bread or the repugnant smell of varnish. At the Chicago World's Fair, a mining exhibit was held in a room saturated with the perfume of the smell of the earth.

A perfume is a symphony. To express a single emotion, no two composers, no two perfumers, would arrive at the same conclusion. The odor symphony must have harmony, unity, originality. It must evoke something in the heart of every man who has the sensory power of perception and the

ILLUSTRATIONS

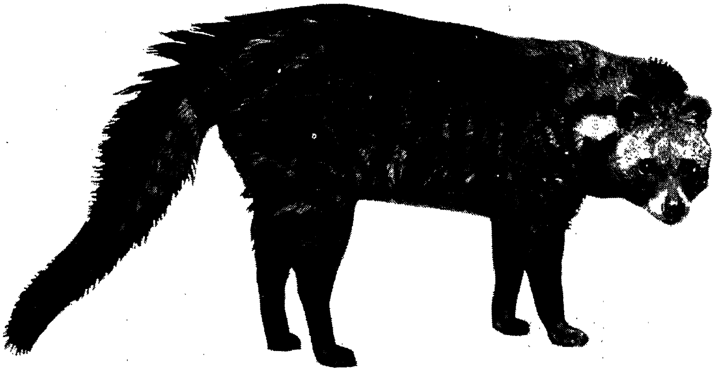


A mother-of-pearl case and the perfume bottle that it enclosed. Type used in France in the eighteenth and early nineteenth centuries.

Distillation according to early Arabian methods.

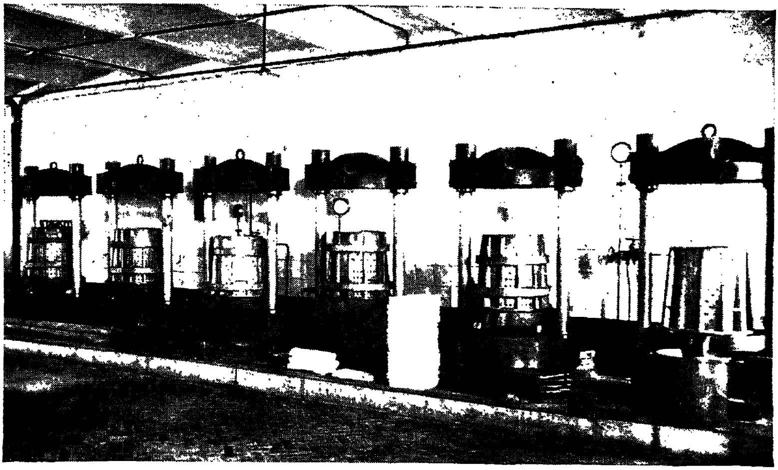
Expression of Italian citrus fruit to obtain the oil.

A worker removing jasmin flowers from the corps in enfleurage process.



Abyssinian civet cat, source of the foul-smelling but valuable civet.

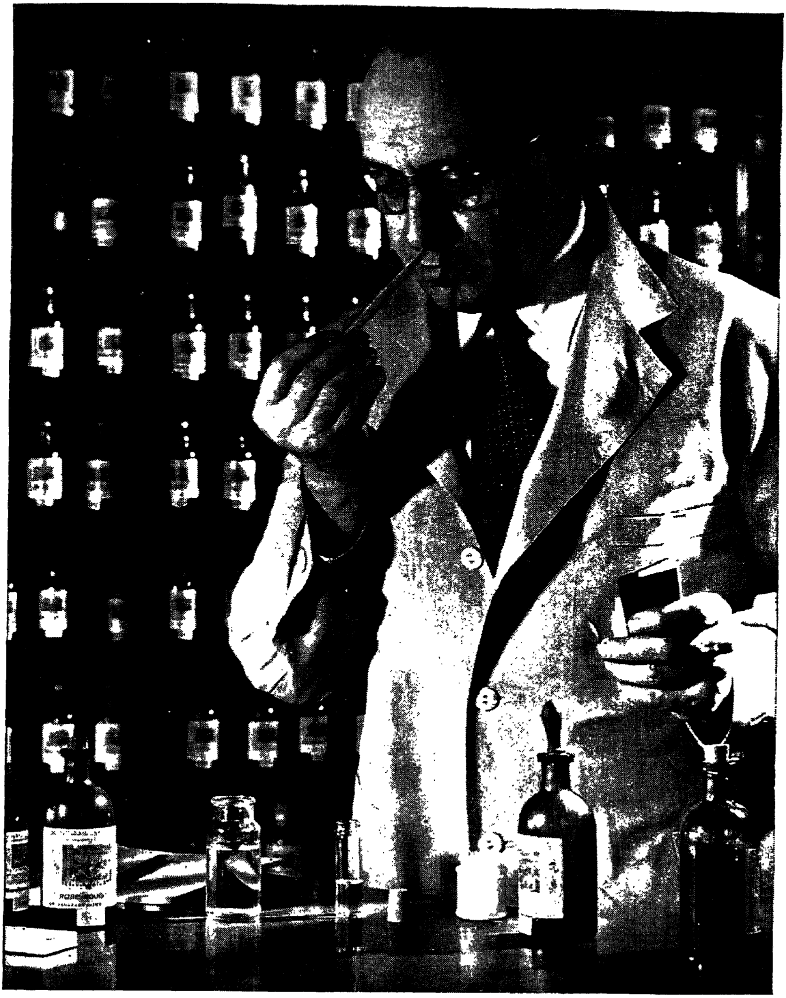
Turpentine—raw material for terpineol—is tapped from pine trees.



A few flowers are still treated by the maceration process.

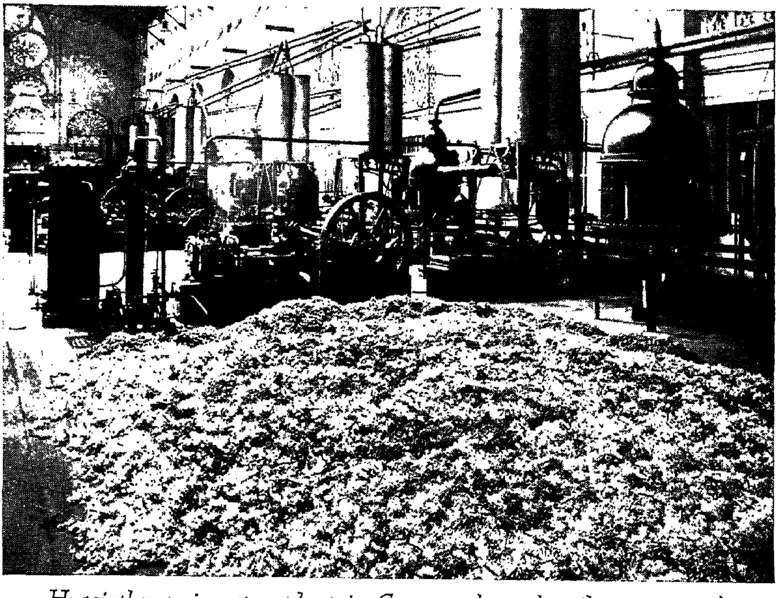
The violet, whose odor Tiemann and Kruger were seeking to capture.

A small quantity of a flavor is drawn up into a pipette, to be weighed and tested in candies and puddings in a flavoring laboratory.



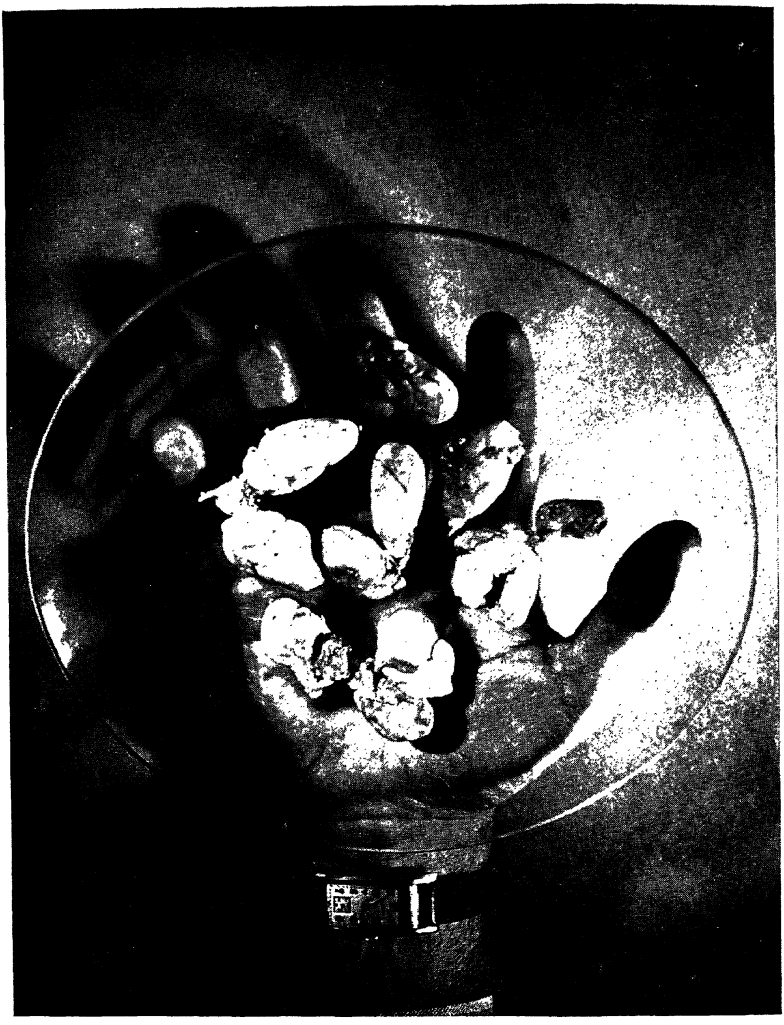
The perfumer's nose is always in action. He smells from a perfume blotter, first through one nostril, then the other, then both together.

Plantation of cultivated lavandin in southern France.

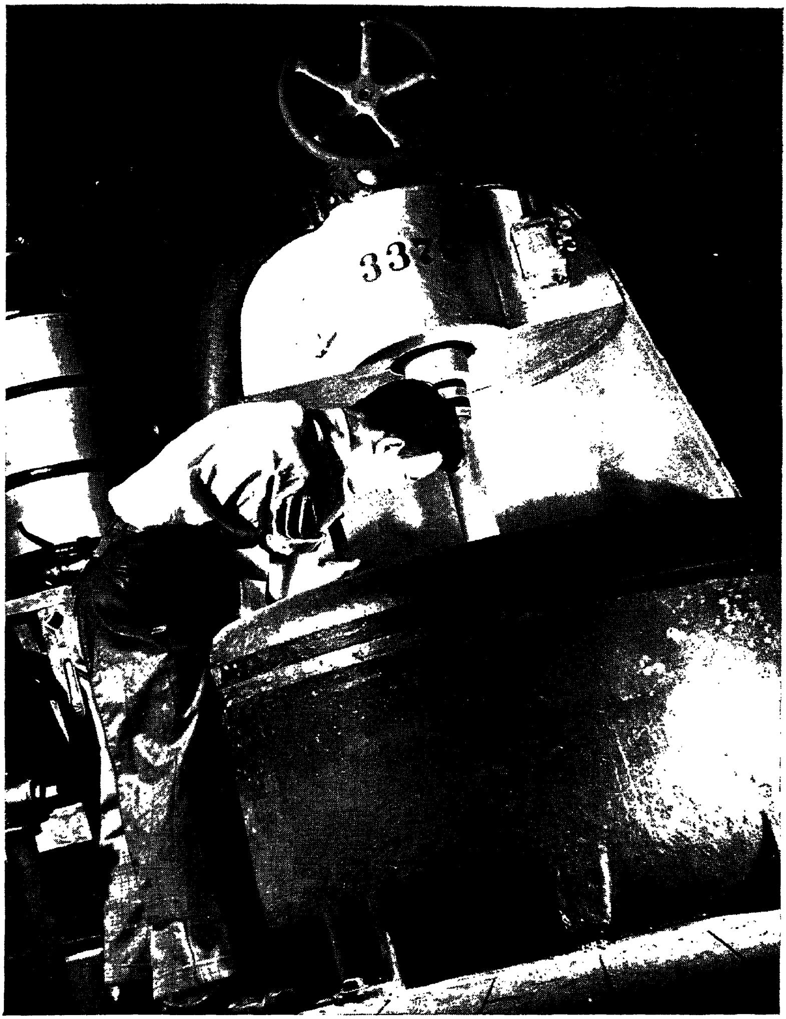


Hyacinths arrive at a plant in Grasse where the oil is extracted.

The rose, always a favorite among flowers and fragrances.

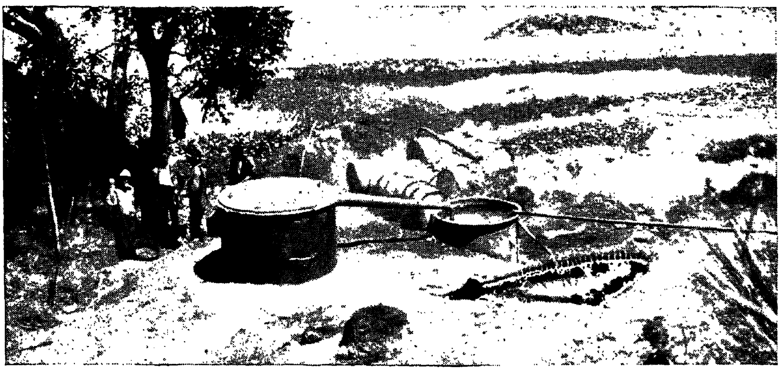


The glands of the muskrat ready to be processed to obtain the musk.



Power-driven centrifuge used in separation of crystals in the manufacture of solid aromatics such as synthetic musks.

Workers in the Grasse fields collecting jasmin flowers.



On Spanish farms, peasants use primitive equipment for distillation.

aesthetic power of evaluation. To each recipient of its message it will have a different meaning, but if it is a great creation, it will stir the soul to its very being, and will attain deserved immortality.

"A thing of beauty," wrote Keats, "is a joy forever. Its loveliness increases; it will never pass into nothingness."

Picture Credits

The author wishes to thank the Houbigant Company for the photograph appearing on page 101; Bettmann Archive for the reproduction of the lithograph showing Arabian distillation; Citrus & Allied Products Company for the photographs of Italian expression and Spanish distillation scenes; Fritzsche Brothers, Inc., for the enfleurage picture on page 103; New York Zoological Society for the picture of the civet cat; Frederic Lewis (photograph by Fred Hamilton) for the pine tree photograph; Jean Niel, Inc., for the maceration scene; A. T. De La Mare Company, Inc., for the violets; Antoine Chiris Company for the lavandin and hyacinth photographs; J. Horace McFarland Company for the picture of the rose; Roure-Bertrand Fils & Justin Dupont for the jasmin field picture; Givaudan-Delawanna, Inc., for the two laboratory scenes on pages 106 and 107 (photographs by Bernard Guth), and the same company for the muskrat gland photograph and the factory scene facing it.

CHAPTER 10

The Genealogy of a Formula

The sweetest essences are always confined in the smallest glasses.

JOHN DRYDEN

OUR portrait of the perfumer would be incomplete without the portrait of a formula. The fragrant vapors that are "confined in the smallest glasses" tell a story of romance and history and adventure. The ingredients have come from all parts of the world, from the Himalaya Mountains to the jungles of Brazil. They come from the labor of the peasant and the research of the chemist. Each ingredient has a history of its own, and all of them, blended together with skill and experience, in a proper proportion, give the result, the desired perfume.

The literature of perfumery is filled with formulas, dating back thousands of years, and in the safes of the perfume houses there are literally hundreds of thousands of unpublished recipes. We shall not add one more here, but rather take a leaf out of a well-known volume and examine it, see how many ingredients a single formula might contain, where they come from, what they smell like, in what proportions they are used.

Any formula that one could choose from a modern and adequate book would demonstrate the essential unity of

natural and synthetic products in the blending of a finished perfume. Hardly a formula could be chosen that would not illustrate the romance and the science of perfumery, or that would not include many of the natural oils, plant and animal resins, and synthetic organic chemicals which we have been discussing.

The formulas for the blending of a perfume whose odor duplicates that of a natural flower are, in general, easier to judge than those that create a new odor.

There are, in addition, large numbers of perfumes which are neither simulations of natural odors nor complete departures from known scents. They are continuations, duplications, refinements, and modifications of the new bouquets of years gone by. It is in this class that one can place an eau de Cologne, although one creation using that name may differ greatly from another; and it is also in this category that one can place the formula of Felix Cola, which we shall analyze in detail.

Here is the odor called "chypre." The name itself has a history, one of the perfumes that came from "the glory that was Greece," from the island of Cyprus, whose French name is "chypre," and whose Biblical name was Chittim, suggestive of shittim wood, a variety of acacia, and referred to in the Scriptures as a sacrifice, in the same passage with spices, oils, and incense.

Hundreds of chypre formulas can be discovered, each with a special character of its own, but with all their differences there is a red thread of continuity that runs through many of them—oakmoss and bergamot.

CHYPRE

by Felix Cola

Santalol	60 grams
Coumarin	90
Musk ketone	30
Musk ambrette	20
Absolute ambrein	25
Oil of estragon	25
Angelica root	5
Sage clary	30
Vetiverol	60
Linaloöl	30
Patchouli	20
Isoeugenol	35
Methyl ionone	50
Oakmoss absolute	60
Bergamot	225
Jasmin absolute	20
Rose absolute	15
Methyl salicylate	2
Lavender	3
Vanillin	15
Heliotropin	35
Ylang ylang Manila	70
Cinnamyl acetate	25
Benzoin gum resinoid	50
Total	1,000 grams

What are these ingredients?

Santalol, as its name suggests, is an alcohol found in the oil obtained from the sandalwood tree. "Sandalwood," writes Richard Le Gallienne, "has a history that goes back five hundred years B.C. The product of an Indian tree, it is still a sacred perfume for religious and funeral rites among the Indian and Chinese Buddhists, and the trade in it in old sea-faring days was full of romantic peril."

Coumarin, whose synthesis was a landmark in the history of perfumery and organic chemistry, obtains its name from the tree that the botanists call the "Coumarouna odorata," of which the tonka bean is the fruit. In 1875, an American perfumer by the name of Clifford wrote a curious and melodramatic poem, from which we quote a few lines:

> 'Tis thus we find the Tonka tree,
> Sprang from a maid beneath the sea;
> Tonka, her name, means "fairest in the land."
> Redeemed, the maiden's pledge she gave,
> The while she sank beneath the wave,—
> "I go to give my lovers, each, my hand."

Musk ketone, called the sweetest of the artificial musks, is closest to the natural musk in its odor. The creation of Baur, its synthesis is closely linked with the beginnings of synthetic aromatic chemistry as an independent industry.

Musk ambrette, the second of Baur's permanent contributions to perfumery, has been called one of the most powerful odorants known. Its name is derived from a pear-

like fruit with a musky odor, which is probably best known in our language because it is the namesake of this synthetic.

Absolute ambrein comes from gum labdanum, whose history is dated back to Genesis, where it was confused with the gum known as myrrh. It has a powerful, pleasant, and musky odor, suggestive of the whale's ambergris, as the similar names would indicate.

Oil of estragon is not commonly encountered in a perfumer's notebook. It is a spicy flavoring oil that is derived from a French herb, better known to the public under the name of "tarragon."

Angelica root, frequently encountered in a chypre formula, is an oil distilled from the roots of a plant whose white flowers inspired its heavenly name. Its odor is strong, spicy, and pleasant, and while the commercial roots come from Europe, the plant is known to be abundant among the vegetation in the jungles of New Guinea.

Sage clary is distilled from an herb that thrives in France. Little known outside of the realm of the perfumer and the flavorist, it is not infrequently met in chypre odors. Its fragrance is classified as akin to ambergris, labdanum, and musk ambrette.

Vetiverol, an alcohol, like santalol, is what the industry calls an "isolate"; it is a substance found in the oil obtained from the root of the vetivert plant. The history of vetivert goes back to the days of the Arab navigators. It is today produced in the rich essential-oil islands of Java and Réunion, and its disappearance from the market during the war was as severe a hardship as any the perfumer had to

face. Constituting 6 per cent of this chypre formula, its characteristic odor will be readily discerned by a trained perfumer.

Linaloöl is an alcohol found in a wide variety of oils, in Brazilian bois de rose, in the linaloe wood and its seed, from which it derives its name, in the Sicilian bergamot, the South American petitgrain, the British lavender. It comes from oils found in every part of the world but retains a slightly perceptible character of the oil from which it has been produced. Its history goes back to the Bible, its nomenclature to the wood oil, the aloes.

Patchouli is the oil obtained from the dried leaves of a plant found in Malaya and Sumatra. In the words of the French author, J. K. Huysmans, it is "the most pronounced of all vegetable perfumes, whose blossom, in the natural state, gives off an odor compounded of wet wood and rusty iron."

Isoeugenol, often known as the "carnation" odor, in a natural state is found in oil of ylang ylang, but is quite easily made from eugenol, a constituent of clove oil.

Methyl ionone is one of the creations of the chemist that has never been discovered in the natural state. Its production depends on the availability of citral, an ingredient of oil of lemongrass, itself an Indian oil, and the acetone homologue, methyl ethyl ketone. With all the beauty of the violet note of ionone, it has a pinelike characteristic of its own.

Oakmoss is not a moss, nor does it necessarily grow on or around the oak tree. It is a resinous substance coming from a lichen and is said to have originated as a perfume substance on the island of Cyprus. In modern times, the best quality

originates in the interior of Yugoslavia. The story of the ten tons of oakmoss that escaped from Yugoslavia just before Hitler's armies marched in, and was buffeted from port to port for twenty months, finally to arrive within a few hours of its final destination, is one of the thrillers of perfume history. For the oakmoss that had survived the fortunes and misfortunes of war never made the last mile; the ship struck a rock and was sunk off the coast of Boston.

Bergamot is Sicily's outstanding contribution to the industry of odors. Linguists trace its name back to the Turkish, *beg-armudi*, which means the "prince's pear." The oil comes from the pear-shaped fruit that grows on the tree of the same name. The eighteenth-century English poet, William Cowper, wrote of his fondness for this scent: "Give the nose its bergamot."

Jasmin is a legend in perfumery. No flower is more revered, more elusive. No odor has so successfully withstood the challenge of the synthetic, commanding a fantastic wartime price in many lands during the Second World War. Pounds, even ounces, were hidden in caches by daring underground workers during the days of the German occupation of southern France. In 1883, in words as prophetic as they were poetic, Huysmans described jasmin as "admitting no imitation, no counterfeit, no copy, which refuses even any approximation."

Rose, a favorite wherever flowers are in bloom, has chosen a few spots on earth to give blossoms that yield oils for the perfumer—Bulgaria, known for its otto of rose—Turkey, a link between Asia, where the attar was said to

have originated with the Persians, and Europe, where it is now developed—and, as always, the Riviera. The literature of all tongues is filled with songs of this fragrance, captured by Swinburne in these lines:

> What fields have bred thee, or what groves
> Concealed thee, O mysterious flower,
> O double rose of love's,
> With leaves that lure the doves,
> From bud to bower?

Methyl salicylate, minty, pleasant, and rather pungent, is almost identical with natural oil of wintergreen, and is today made synthetically from coal-tar derivatives, through the intermediate compound, salicylic acid, which can also be readily transformed into aspirin. Though present in the formula under consideration only in the quantity of 1 part in 500, its influence will be felt. Seldom, in fact, can this pungent odor be used in a fine perfume except in minute quantities to give a trace effect.

Lavender, an odor associated with a color, comes from a plant grown in southern France and in parts of England, and is a favorite odor of the British. The English oil is generally placed at a higher value than the French. Many authors have shown a fondness for lavender, but what was our surprise to find this delightful quotation—of all places—in Sir Izaak Walton's *The Compleat Angler* (Chap. 2):

> An honest Ale-house where we shall find a cleanly room, Lavender in the Windows, and twenty Ballads stuck about the wall.

Vanillin, once the costly chemical isolated from the vanilla bean, today traces its ancestry to the waste liquors of a paper mill, to the by-products of a chemical plant producing moth-proofing agents, or to Madagascar's oil of cloves, whose carnationlike isoeugenol, already placed in this formula, can be oxidized to vanillin.

Heliotropin is made from safrole, found in America's own sassafras, the flavoring ingredient of root beer. However, the domestic safrole-bearing oil is not a commercially practicable source for heliotropin. This chemical derives its name from the flower whose odor it resembles. "On the darkest day of the year," writes Mary Webb in *The Spring of Joy*, "with sleet in the air, you can find in the sombre shelter of a yew-tree a pale blossom scented like heliotrope. It is only the wild butterbur, yet its delicacy lifts the wintry day on to the steps of summer."

Ylang ylang obtains its repetitious name from its meaning, the flower of flowers. The tree whose flowers give this oil is grown in Thailand, Réunion, the Philippines, and elsewhere, but perfumers are unanimous in their preference for the Philippine oil.

Cinnamyl acetate, though named for a substance found in cinnamon oil, is not prepared from the natural oil. By a process worked out by the great chemist, Claisen, benzaldehyde and acetaldehyde are condensed to form cinnamic aldehyde; in a delicate operation requiring the use of aluminum, the aldehyde is transformed into an alcohol, which in turn is used for making cinnamyl acetate.

Benzoin resinoid is an extraction from benzoin tears,

which originates in French Indo-China and Thailand. It is not quite as viscous as other resins, but has the equally valuable fixative properties, together with a sweetish note of its own.

Here, then, is a perfume formula, as typical as any. None of the substances smells like the finished perfume, but, added together in the given proportions, they produce the odor known as chypre. Another formula might start with the specialty of a Swiss or French laboratory, might have more animal products, or other types of oils or synthetics.

The originator of such a formula might have sat back in self-satisfaction in his laboratory, in disregard of the harsh realities of a world at war. He might have lived in a world of his own creation, if such were his desire—were it not for the events that led up to Dunkirk and Pearl Harbor.

The natural oils in this formula come from southern France, Yugoslavia, Bulgaria, and other spots in Hitler's erstwhile empire. They come from Madagascar and Réunion, for a long time cut off from America; they come from such places as Java, Sumatra, Thailand, French Indo-China, the Philippines, all once held by the Japanese, and from India, where boats traveled only for the most essential purposes. It would be difficult to name a group of raw materials that became less available to their users than natural essential oils during the war.

The situation in aromatic chemicals was not much more encouraging. We are wont to think of chemicals for war in terms of poison gases, explosives, and perhaps such

medicinals as the sulfa drugs. The chemical industry, however, is to a tremendous extent an "intermediary industry," the supplier of goods that never see the light as end products in themselves, but that are used in the development of everything around us—of metals, textiles, foods, medicines, soaps, paints.

In the tremendous consumption of chemicals for war purposes and for the essential well-being of our country, materials were used that otherwise might have been available for the manufacture of perfume chemicals. The shortage of aromatic chemicals was therefore traceable, not to their use in making synthetic rubber or explosives, but to the fact that the aromatics had to compete with synthetic rubber for the same raw materials.

We have mentioned a number of coal-tar derivatives. Benzene, for instance, is the starting material in the most important process for the manufacture of phenyl ethyl alcohol, and the latter in turn, in addition to its widespread use for its rose odor, is the starting material for the production of phenyl ethyl acetate, phenyl ethyl propionate, and a group of similar esters.

Nor does this end the dependence on benzene. It is also used in the manufacture of benzophenone and acetophenone, and in the manufacture of nitrobenzene, which is used in producing eugenol vanillin.

The story of dependence on benzene can be repeated with toluene, which is used by the petroleum and explosive industries, among others. From toluene is made benzyl chloride, which is the raw material for the manufacture of

phenylacetic acid, benzyl alcohol, benzyl acetate, benzyl benzoate, and related products. But its most vital use to the field of perfumery is in the synthesis of benzaldehyde, either by a process of direct partial oxidation to the aldehyde, or through benzyl chloride, benzal chloride, and benzyl alcohol as intermediates.

Benzaldehyde, short in supply because of its dependence on toluene and due to the military usages of the aldehyde itself, is used by the aromatic chemical manufacturer to make cinnamic aldehyde and phenyl acetaldehyde, which in turn are the raw materials for cinnamic alcohol, phenyl propyl alcohol, and any number of other important aromatics.

Our story could be continued to show the dependence of the industry on formic acid, acetic acid, orthocresol, ethyl alcohol, and acetone, or we could go through the formula books, taking the synthetic musks, the aromatic and the fatty aldehydes, and other organic chemicals and show why each aromatic was in short supply.

Aside from the fact that there was not a single material in this formula easily obtainable during the war, our perfumer found his calculating machine giving him fantastic costs of production. Bergamot, making up some 22 per cent of the formula, increased two and a half times in price from the eve of the outbreak of the Second World War until the beginning of 1945. By 1945, patchouli cost about nine times the prewar figure, and oakmoss, if a pound could be obtained, would have changed hands at several times its former price.

Jasmin and rose absolute, two items that together made up more than a third of the cost of the perfume before the war, increased some tenfold in the case of jasmin absolute, and fivefold for a given quality of otto of rose.

For his raw materials (exclusive of labor, packaging, and other expenses) it cost a perfumer from $25 to $30 to make up one pound of this perfume base in 1939, and between $125 and $130 for the same base in 1945.

In an analysis of this price rise, published in *The Givaudanian* of August, 1941, before the situation had gotten completely out of hand, Eric C. Kunz pointed out that increases in price were traceable to the inflationary trends in essential oils and other naturals, whereas aromatic chemicals had resisted such price rises.

"The major increase in the cost of any formulation," this writer pointed out, "is due to the flower oils and the oleoresins and similar fixatives, and only to a very slight extent is such an increase traceable to the truly synthetic products. Synthetic aromatic chemicals derived from coal tar contribute the least toward inflationary prices of formulations.

"Perceptibly higher prices are now asked for isolates or derivatives from essential oils, such as the ionones derived from oil of lemongrass, the price of which has increased from thirty cents to $1.90 per pound. If one pound of lemongrass were needed for one pound of any given ionone or methyl ionone, the situation would not be so bad, but on the average we need two pounds of oil of lemongrass to make one pound of ionone of medium quality. If prod-

ucts of especially high purity are desired, we need three, four—and in some cases ten—pounds of oil of lemongrass in order to produce one pound of the finished ionone."

Under these circumstances, many perfume formulas have undergone changes. Few formulas could remain untouched by the cataclysmic events in the Atlantic and Pacific. But it is a tribute to the industry that perfumes of all types of odors, and of undeniably high quality, have been produced without interruption. The chemist has created a little where there was none, and the perfumer has made a little go a very long way.

CHAPTER 11

A Matter of Taste

A little girl called Goldilocks walked by the house, and the wonderful smell of porridge floated out to her. "M-m-m-m-m," said Goldilocks, "that smells good!" And she hurried into the little house.

THE THREE BEARS

FROM time immemorial the science of flavor has been inextricably linked with the blending of odors. The first perfume materials of the ancients and most of the odorous substances found in Biblical recipes were destined to take their place primarily as flavor ingredients.

Down through the ages, the twin sciences worked hand in hand. Spices were prominent in causing wars and dictating treaties of peace. When Columbus set sail for a new and shorter route to India, he was seeking to keep open the Spanish spice trade with the East. And when Ponce de Leon went forth in search of the Fountain of Youth, he came upon the Indians' sassafras, today the flavoring material in every drink of root beer.

The first synthetic aromatics in the history of perfumery, vanillin and coumarin, are primarily used for their taste and not their odor. Just where a border line between the

two senses of taste and smell can be found is a matter of debate. It is easy to smell a substance without tasting it, but extremely difficult, if not impossible, to appreciate flavor without odor, in the case of chocolate, though sugar and salt, for instance, are tasty but odorless.

There are said to be four genuine taste sensations: sweet, salt, sour, and bitter. These can be perceived by the taste buds independently of any olfactory perception. All other taste, it is claimed, is actually smell.

The very word "flavor" probably comes from the French *fleur*, formerly spelled *flaur*, a word associated not with taste but with odor.

Though little realized by the consuming public, the great industries of the manufacture of flavoring essences and of perfume bases are bound indissolubly to each other. Some companies may specialize in the former and others find greater achievement in the latter, but there is a unity of method and material not often encountered in two dissimilar fields.

Every time a source of perfume oils is cut off, or a new synthetic produced, the flavoring chemists (who have recently been named the "flavorists") are affected. They use the animal products, essential oils, and synthetics, and a host of other valuable substances that do not lend themselves to the science of odor. The formula of the flavorist bears a curious resemblance to that of the blender of odors, yet his art is not the same.

The customer of the flavorist is all the world. None of us can sit down to a meal without tasting his products.

Aromatic flavoring materials are used in delicatessen meats—frankfurters, sausages, Bologna, *salami*, and the like; in soft-centered chocolates and hard candies and chocolate bars; in gelatin desserts, bottled soft drinks, and unbottled syrups. They are found in tobacco, gums and gumdrops, crackers, biscuits, ice cream, medicine, and other things we taste, too numerous to mention. The problem of the flavorist becomes one with that of the perfumer when the perfume must be pleasant on the tongue, to cover up the taste of castor oil, as, for instance, in the making of lipsticks.

The chief aim of the flavorist is to create a mixture that will simulate and enhance one of the known natural flavors and be specifically directed for a given end use. Where the perfumer's greatest ingenuity finds play in making an odor that is a departure from all others, the flavorist finds greatest achievement in the exactness of his duplication of known flavors.

Paging through a flavorist's formula book, we find recipes covering raspberry, strawberry, maple, walnut, apple, banana, peach, and the like. The emphasis on a complete departure from known taste sensations, as found among the creators of perfumes, is absent.

For this purpose, why not use the fresh juices of the fruits and berries, or at least a concentrate or extract from such juices? Because such juices are not always available, and would not in many cases be usable in their natural forms. They would not go so far, and would involve an expense out of all proportion to their value. There are

times, nevertheless, when the natural fruits and the synthetic flavors are used side by side, complementing and strengthening each other and blending into a single taste more true to the original fruit than could be obtained without the aromatics.

In the flavor formulas one finds almost all the oils and chemicals that play a prominent role in perfumery, together with new names, as "feenugreek," used in compounding a maple taste, and one encounters essential oils obtained from such plants as celery and lovage.

Where perfume materials are encountered in flavor formulas, they make a different contribution. Just as one could not think of a violet perfume without ionone, one could not set out to make a raspberry flavor, for any purpose, without this substance. Methyl anthranilate, indispensable for the orange blossom note, is the first thing a flavorist takes off the shelf when he thinks of a grape compound.

The group of organic chemicals known as the "esters" have numerous members whose use in flavors is not duplicated in odors. These esters are prepared by heating a mixture of an alcohol with an acid (or the salt of an acid), and they are frequently made to order right in the flavoring laboratory.

Though the esters are found in fruits and vegetables, the flavorist is not seeking to build up chemically a formula the same as in the natural fruit, but to give the same effect with different ingredients. His knowledge of the chemicals that go to make up the flavor of an apple is limited, but he can instantaneously name the applelike flavors on his shelf.

From creating hundreds of formulas and reading thousands of others, he has acquired a cumulative knowledge of how to give taste to the tasteless.

If he wishes to build up a raspberry for ice cream, his formulation will start with ionone. To this he adds, perhaps, some benzyl acetate, which we have met before in jasmin and lilac. He would impart the fruity character with esters, perhaps ethyl acetate and ethyl butyrate, and add a substance called "undecalactone." His flavor would require, to round it out, one of the natural essential oils, with a little citral, a bit of vanillin, and some civet. Indeed a strange conglomeration of odors, but in the right proportion, and on the tongue, they are almost indistinguishable from the flavor of the natural berries.

In this process minute quantities are used. Most of the substances have previously been cut. Instead of oil of coriander, there will be a solution of 1 part of the oil to 128 parts of solvent; or the dilution may be as high as 1 part to 1,028 of solvent. The dilutions can be in alcohol, propylene glycol, or a mixture of either of these substances with water. If the flavoring materials were to be used undiluted, an effect would be obtained so strong, so unpleasant and overpowering, that even the flavorist could not make up his mixture, much less pass judgment on it.

How far these substances go in providing taste can be illustrated by these figures: In a gallon of a coconut flavor for a soft candy there are approximately six ounces of actual flavoring materials. The rest is the neutral solvent or diluent. Then one ounce of this flavoring essence, diluted

as it is, can be used to impart a coconut note to 400 pounds of soft-centered candy. In other words, one pound of coconut-type oils and chemicals is used as the flavoring material for about 130,000 pounds of candy. Contrast this with perfume, where a gallon of an alcoholic solution contains up to a quart of oils and chemicals, or even with a cake of soap, which contains from 1 to 2 per cent and sometimes a fraction less of odorous material.

Unlike the perfumer, the flavorist is in constant danger of overusing the artificial flavors. The tongue seems to be much more sensitive than the nose to an undesired by-taste or impurity. There are cases of tasters who, on eating materials that contained minute quantities of flavors, rejected the food, and microscopic examination was later to determine that the flavor had been contaminated with traces of undesirable substances, which the analytical laboratory had not detected, but the tongue had found.

The flavorist faces the problems of the perfumer, and others of his own. He gives thought to stabilization, fixation, and compatibility, and resolves them in a similar manner. He finds that a good flavor improves with age; there is an ever-so-slight interaction with sugars, alcohols, and perhaps a very slight cross-esterification among the esters, insufficient to change the character, but imparting to the extract a mellower tone.

A flavor must be able to withstand the heat of the oven and the chill of the freezer without breaking down. And since it is actually to be used, if we disregard the solvent, in a proportion of 1 part to 100,000 or more, it must receive

an excellent distribution. If one piece of candy were to have five times the proper proportion of flavor, its taste would be repugnant; and another might give just a waxy, tasteless sensation in the mouth if the flavor did not reach that unit of the 100,000 pounds.

Flavor, like odor, is closely related to all the other senses, and particularly to the power of suggestion, which will be discussed more fully a little later. But even more than the perfumer, a flavorist knows the importance of color. "A strawberry must taste red," is the way the chemist puts it.

The flavoring chemist works in a room (or a building) completely set off from the laboratory of the perfumers. One of his bottles, opened for just an instant, may bring sarcastic comment from passers-by all day long. The perfumer could not afford to allow his material to become corrupted by these strong and, for him, undesirable odors. And the flavors, too, would not be aided by the vapors of pleasant-smelling perfumes.

But this does not mean that the arts are separable. The flavorist uses his nose. He sits with a perfume blotter at hand, but he is more interested in the smell after a day or two, during which time the blotter is exposed to the air. And once in a while, he puts the blotter on his tongue.

His laboratory is a strange-looking sight. Where the perfumer must have the facilities to make lipsticks, rouges, soaps, and eaux de Cologne, the flavorist has candy machines, ice-cream mixers, malted-milk shakers, homogenizers, refrigerators, and a stove for baking good biscuits.

This flavor man is apt to walk around the office in the middle of the morning and ask workers to eat chocolate puddings. He notes not only their preferences, but which of several puddings they tried first. In his scientific public samplings he does not lose sight of taste fatigue, accumulation of taste sensations, the difference between the feeling of the pudding in the dry mouth and of the same pudding in a mouth filled with a chocolate aroma, the difference in taste perception before and after lunch.

Yes, the flavorist uses his nose, but the ultimate test is that of taste, and thus flavors have given rise to that legendary and curious group of workers, the tasters, who sit and sip samples of wines and teas, or who chew pieces of candy all day long. If the youngsters of America knew more about these men and women, the ambition of every school child would surely be to become a professional candy taster.

A most interesting description of the art and technique of the beverage taster is found in Crocker's book, *Flavor*. The professionals use methods of tasting and a language of taste peculiar to themselves. In their colorful language, this book points out, tea can be bakey, stewey, brisk, colory; coffee may lack body and wine may be too flabby.

Again like the perfumer, there are problems of duplication that have baffled the best artists in the field. No one can create a cup of coffee or a glass of tea that does not contain the natural beans or leaves. There are excellent banana ice creams without bananas, but no good cranberry sauce without cranberries.

Some of the natural oils of the flavoring laboratory are too strong even for a tightly sealed bottle. The bottle must be placed inside another, and both are sealed. So powerful is oil of garlic, for instance, that after handling this outside bottle, one's hands definitely have a garlic odor. This garlic oil might be used in a one-half of 1 per cent solution; the solution makes just a minute percentage of a flavoring essence; the flavor is then cut to 1 per cent to the gallon, and this gallon is used in equally small quantities in *salami*. Yet any careful eater can detect the taste of the garlic.

The curios of a flavor shelf include, beside garlic oil, its closely related oil of onion; the pungent valerianates; the rather disgusting skatole; and the most fragrant and flowery oils on a perfumer's shelf. It is hard to conceive of rose oil in food, yet a place it has, if it is a tool in the hands of the careful, the skilled, and the experienced.

CHAPTER 12

A Science in Search of a Language

How forcible are right words!

BOOK OF JOB

In one respect the story of odor is unlike that of any other science. For scents defy accurate description. There are no exact terms by which a smell can be characterized. This is a science without a language.

The efforts to use words to describe odors are feeble. A chemical may be called fragrant, fruity, pleasant, or repulsive, but these are generalities that may be applied to many odors, unmistakably different one from another. Or the perfumer is fond of calling his odor "characteristic," by which he means that it has a smell peculiar unto itself.

We state that the chemical known as "diphenyl oxide" smells like geranium—but what does geranium smell like, unless it is diphenyl oxide?

Oil of anise is quite easy to describe; it has the odor and flavor of licorice. The descriptive term, "licoricelike odor," has meaning for us only because we all have a mental con-

ception, inexpressible in exact words, of what this odor is like. It evokes a memory and the smell comes to mind. But as soon as we try to describe the odor of licorice, we are using general terms such as "spicy" or "pungent," or we have completed a circle by saying that licorice has an odor reminiscent of anise.

We can say that terpineol smells like lilac, and that lilac is sweet and fragrant and flowery and pleasant, but so are rose, jasmin, lily of the valley, and violet. Yet these odors, so different from each other, defy our search for words, in English or any language. We cannot define in the sense of delimit.

Actually, when we say that anise oil smells like licorice, we are really saying that licorice smells like licorice; for it is the oil of anise, or its main ingredient, anethole, that gives this child's candy the odor and taste with which it is identified.

And when we say that terpineol smells like lilac, we are taking unpardonable liberties with the olfactory senses. It is like stating that mauve looks like purple. Or, to continue the analogy with color, when an author describes benzyl propionate and lauryl acetate as "each having a jasminlike odor," he might just as well be saying that midnight blue and sky blue are the same color, because they are both blue.

In fact, the color designation of blue for two shades so different is the more excusable. The term "blue" covers a definite range in the spectrum. The blue light waves are measurable with accurate instruments and expressible in mathematically accurate terms. If the term "blue" is too

vague, then "midnight blue" represents a smaller range on the spectrum.

If the color experts had to depend on a chart that showed the range of hues and tints, one gradually leading into the next, they could make a reasonably accurate match of one shade with another. The eye has the advantage over the nose in that the former is more sensitive to variations, less dependent on the individual personality of the perceptor, on fatigue and psychological suggestion.

Colors could not be scientifically defined and classified, however, if we did not have available the spectrophotometer and the photoelectric cell. These instruments permit a scientific determination of the accuracy of a duplication of a shade. More than that, they permit a mathematical description of a new color material of a nature so exact that anyone familiar with the language and reading the description can know what the color is.

Such is not the case with odors. We can take a chemical of the greatest interest to perfumery and make the most accurate measurements of its properties. We can express in mathematical, chemical, and physical terms its viscosity, or rate of flow; its specific gravity, refractive index, surface tension, vapor pressure, and can state what impurities are present and their quantities to several decimal places. We can weigh a sample of the substance to an accuracy of one two-hundred-thousandth of an ounce. But the most important property of the chemical, its very *raison d'être*, defies physical measurement and appropriate description.

Why a science without a language? Surely not because

capable men failed to turn their talents to the creation of scientific word descriptions of odors. Lacking a satisfactory explanation of the origin and mechanism of odors, and lacking any physical instruments for the measurement of odors, the creation of a scientific nomenclature has not been possible. A trained nose is the last word in passing on a smell. In an age when laboratories have electron microscopes and cyclotrons, we are without "odorimeters," although several instruments have been devised for measuring odor intensity.

Odor is still a mystery. The chemist who seeks to create any given new chemical cannot predict whether or not it will have an odor, and if so, what type of odor and what strength. It may be that he is familiar with chemicals so similar in the structure that he can make a guess—a purely empirical guess—about his new and as yet unsynthesized substance, and quite frequently he will guess wrong. Some substances very similar in chemical structure smell alike, and others do not. Some have odor and others have none. And, on the contrary, chemicals entirely different in their architecture are known to smell so much alike as frequently to be confused with one another.

What is there about the vapors of a given chemical that on striking the nose gives the sensation we know as the odor of the rose, or of the vapors of another substance smelling like rotten eggs? What physical characteristic has the vapor that causes an odor, and what takes place at the surface of the olfactory nerve, what type of chemical or physical reaction that brings forth a smell, makes it strong

or weak, a fragrance or a stink? These are questions for which science still gropes for an answer.

Odor has failed to be harnessed to a mathematical formula that would give it a relationship to the other properties of a chemical. Heavy tomes of studies of physical chemistry are filled with symbols showing relationships among volume, pressure, surface tension, light refraction, and dozens of other physical characteristics, but none suggests a mathematical formula for smell.

For many years perfumers, failing to find a language for their tools, have attempted to group odoriferous substances into odor classes. Such classes are highly personal, and while they have a limited value, we would go astray if we confused them with scientific classifications. This point was brought out most succinctly in 1927 by Prof. Marston T. Bogert of Columbia University in his paper, "Synthetic Organic Chemistry in the Study of Odorous Compounds":

> The description of a perfume will vary with the describer. . . . The physiological, psychological or aesthetic classification of odors are unsatisfactory. . . . An exact and impersonal scientific classification of odors, comparable to that available for colors, seems clearly unattainable in the light of our present knowledge. The best that can be done is a more or less superficial grouping into types of classes which to the observer seem to bear a sort of family resemblance to one another, and we therefore speak of (for example) lily type, rose type, musk type, of odor, but the boundaries of these groups are both vague and variable.

The efforts made by many investigators to break down odors into classes, which we shall briefly summarize, all add up to a confirmation of this statement. This does not mean that classifications lack value; the limitations of their value, however, should always be kept in mind.

Odors lend themselves quite easily to classification by chemical groups. Aromatic substances might be esters or aldehydes or might belong to some other class of compounds, and from that point we describe certain substances as having "ethereal" odors, and others as being "aldehydic." By that we mean that there seems to be something in common among a great many of the odorous chemicals in one group, and when this common note is outstanding, or a member of a group is typical, we use this term. The chemist does not lose sight of the shortcomings of this method. The aldehydic smelling chemicals can, and do, have scents entirely unlike one another; some members of the group are entirely odorless; others do not have the character of the group at all; and still other chemicals, not in this group, suggest the aldehydes by their smell.

For example, for many years it was said that violet-smelling chemicals were always ketones. Both ionone and irone were ketones, it was pointed out. This theory proved to be baseless, however, when the odorous principle of the violet flower was finally isolated and found to be an aldehyde.

This method of grouping according to chemical structure is then applied to the essential oils, classified according to the substance giving the major contribution to the fin-

ished odor. Thus, one writer, M. P. Otto, has a group of essential oils which are the phenols and phenolic derivative group, and within it a subgroup known as the "anethole-estragole group," under which come anise, star anise, and estragon.

The same writer, among others, has divided the essential oils according to their origin, a purely botanical classification, according to species and variety. Other writers have classified them according to whether they are derived from the root, leaf, stem, or other part of the plant. Such classifications are of greater interest to the botanical investigators of essential oils than to the perfumer using them. Similarities in odor types found among one group derived from botanically related plants are none too striking and, if they do exist, are generally due to a repetition of the same chemical constituents in different related plants. As for those who would find that all root-derived oils have an odor in common, this is at variance with the experience and opinion of most perfumers.

Reverting, then, to what Bogert calls "types or classes which seem to bear a sort of family resemblance to one another," the efforts to break down odors into such classes have been numerous, dating back to a system devised by the Swedish naturalist, Carl Linnaeus. These classifications are highly personal, and may run from putting all odors into two groups, called pleasant and unpleasant, to placing them, as did the Dutch authority, H. Zwaardemaker, into nine main classes and many subclasses.

The groups of Zwaardemaker, with examples, were

ethereal (ethyl alcohol, diethyl ether, amyl acetate); aromatic, which includes the almond type (nitrobenzene), camphoric (menthol), and citric (linalyl acetate and valeric acid); ambrosiac (musk); allyl (ethyl sulfide); cacodylic (trimethylamine); empyreumatic (aniline, toluene, guaiacol); caprylic (capric acid, acetic acid, and again valeric acid); narcotic (pyridine, pulegone); and the nauseous (indole).

These groups were reclassified by many workers, particularly in an effort to bring them down to fewer numbers, of which Crocker and Henderson, working at the Arthur D. Little Laboratories in Boston, worked out four: fragrant or sweet; acid or sour; burnt or empyreumatic; caprylic, hircine, oenanthic or goaty.

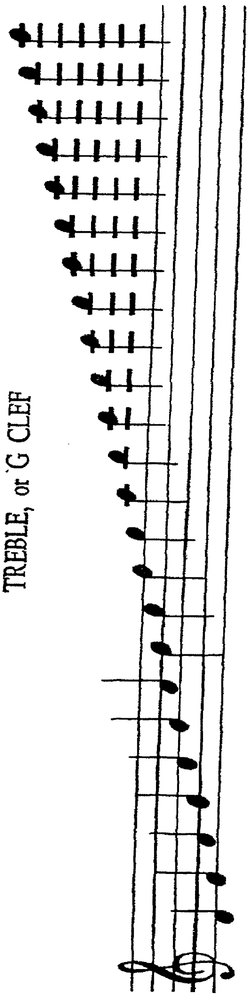
From this point, Crocker and Henderson worked out a system of giving a numerical evaluation to a given odorous substance, depending on the degree of fragrance, sourness, burniness, and goatiness that could be detected by the nose. Admitting the personal element of individual opinion, which plays no little role, they found that for each of the four factors, there were discernible eight different degrees of odor. A 20 per cent solution of acetic acid, which we would describe as having the familiar smell of vinegar, they found to have the third degree of fragrance, the eighth degree of sourness, no burnt effect at all, and the third degree, again, of caprylic effect. The solution had an odor numerical value of 3803.

This method gives odor values of great similarities for smells that are not only widely different, but have varying

intensities. Eugenol, camphor, skatole, and benzyl alcohol all have the fragrance number of five. The practical value of a system that is so completely dependent on personality, and that delimits so little as to include these four widely different substances under one "fragrance number," is difficult to see.

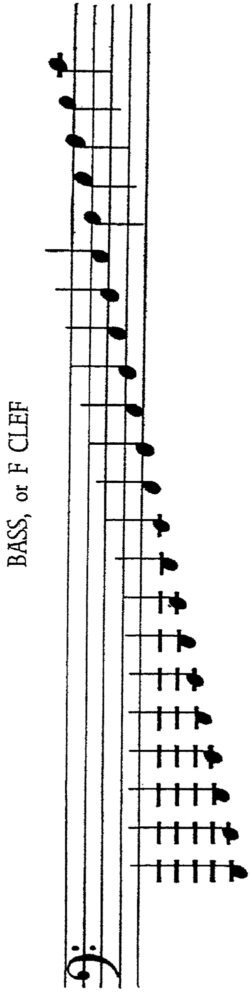
These scientists did make a positive contribution to odor description in drawing attention to the differing and seemingly contradictory notes in a given odor. A substance that is fragrant may (and usually does) have something of the sour about its scent. The Crocker-Henderson system is, in our opinion, a step forward from the classifications of Linnaeus and Zwaardemaker, inasmuch as it highlights the conflicting elements that add up to form any odor.

Another contribution to the field of odor classification was made by the famous perfumer and perfume historian, Septimus Piesse. This unique figure in the history of the science created what he called an "odophone." The odors were like sounds, he pointed out, and a scale could be created going from the first or lowest note, the heavy smell, to the last or highest note, the sharp smell. In between there was an ascending ladder. Each odor note corresponded to a key on his odophone, and in the creation of a happy mixture of many different odors, which we call a "bouquet" and which every finished perfume must be, the creator seeks not only to hit the right notes, but to strike those notes which go with one another. His perfume must not be out of tune.



F	Civet
E	Verbena
D	Citronella
C	Pineapple
B	Peppermint
A	Lavender
G	Magnolia
F	Ambergris
E	Cedrat
D	Bergamot
C	Jasmin
B	Mint
A	Tonquin Bean
G	Syringa
F	Jonquil
E	Portugal
D	Almond
C	Camphor
B	Southernwood
A	Vernal Grass (new Hay)
G	Orange Flower
F	Tuberose
E	Acacia
D	Violet

The gamut of odors.



C Rose
B Cinnamon
A Tolu
G Sweet Pea
F Musk
E Orris
D Heliotrope
C Geranium
B Stocks and Pinks
A Balsam of Peru
G Pergalaria
F Castor
E Calamus
D Clematis
C Santal
B Clove
A Storax
G Plumeria Alba (Frangipani Plant)
F Benzoin
E Wallflower
D Vanilla
C Patchouli

The gamut of odors.

Septimus Piesse pictured himself in his laboratory coat, a white-haired maestro banging away with inspired harmony at the keys of a fantastic odor piano, his agile fingers bringing forth, not beautiful sounds, but fragrant vapors.

If the efforts at odor classification have not brought forth an acceptable theory, the same cannot be said of odor intensity and odor perceptibility. During the last fifty years the groundwork for studies along this line has been laid, primarily by the already mentioned Zwaardemaker, as well as by a number of people interested in odor from the neurological and physiological points of view.

Of great interest, and not sufficiently known even to the perfume industry, is the work of a number of doctors under the leadership of Charles A. Elsberg at the Neurological Institute of New York, during the years 1935 to 1937. Elsberg and his colleagues, in an exhaustive series of papers entitled, "The Sense of Smell," described a simple apparatus which they constructed to test the smallest volume of an odorous substance, delivered through both nostrils at the same time, necessary for identification of an odor. They called this the "olfactory coefficient," and they found variations of only the slightest nature from one tested individual to the next. They used forty different individuals, and thirty-six different odors—odors with which these people were familiar, presumably because of their contact with them in the clinic and laboratory. They found it necessary to have 5 cubic centimeters of benzene, 10 of xylene, 15 of camphor, to be recognized when their apparatus was used. They then pointed out that the boiling point

of benzene is about 76 degrees, of xylene 140 degrees, of camphor 220 degrees, and that a clear relationship exists between the boiling point of a substance (or, in the case of an essential oil, the boiling point of its main constituent) and this olfactory coefficient.

Modifying what we have already said about the impossibility of harnessing odor to some mathematical formula, it is well to point out here that these investigators created a formula that they found workable: that "one molecule of an odorous substance in every 100 molecules of a volatile non-odorous substance will raise the boiling point of the mixture by a nearly constant fraction of its value—approximately 0.0105."

The work of Elsberg and his colleagues has not been sufficiently studied or analyzed. It is a challenge to the scientists in perfumery, and should command more attention than it has in the past. Its merits and demerits should be examined, and the theories and formulas, if found wanting, should be corrected or rejected; or if, as does not yet seem likely, they are found to give a positive clue to the science of odor, they should continue to be studied and developed.

Of all the research workers in the field, none has worked more assiduously than Zwaardemaker, and his remarkable studies of odor intensity constitute a monumental achievement. For these studies he constructed a machine, the merits of which have been debated on many occasions. Without going into the question of the margin of error, which would be much greater with the most highly trained individual

than with an ordinarily efficient machine, let us examine his results while bearing in mind that even the Zwaardemaker apparatus depended on the perception of a human nose for its accuracy.

"The olfacty of an odor," he writes, "is the threshold or minimum perceptible concentration expressed in grams per cc." He takes ionone, and states that 16×10^5 molecules of ionone are perceptible in 1 cubic centimeter of air. Translated into grams, this would mean that it would require something less than one million-billionth of a gram of ionone to be detected in 1 cubic centimeter. To be somewhat more exact, the olfacty of ionone is 3.2×10^{-14}, which means that after the decimal point you place thirteen zeros and then put down the figure of 3.

Continuing, we find that vanillin has an olfactory number of about 5×10^{-13} and ethyl alcohol a number of 2×10^{-7}. What does this mean? Simply that it takes about fifteen times as much vanillin as it does ionone to be perceptible, and it takes about twenty million times as much ethyl alcohol as it does ionone to be detectable.

There are great possibilities in this work. Is the same effect obtained when tested in a neutral solvent, or when ionone is tested in diethyl phthalate and ethyl alcohol is tested in water? Does the same ratio still apply? Unfortunately, there are great disagreements, not only between the figures of Zwaardemaker and other authorities in odor intensity measurement, but even the same investigator has not been able to duplicate his results.

If we take any substance and give it an odorome number,

arbitrarily, of 1, this would be a measurement of its odor intensity. Then, if we find that a second substance requires twice as great a concentration to be detected, it would have a number of 0.5, and a third material may require only one one-thousandth as great a concentration, and this would have a number of 1,000.

Without attempting to define the beauty or the characteristics of differing smells, and without considering the nature of odors which change upon dilution, we could have a numerical value of comparing odor intensities.

Bearing in mind the tremendous margin of error and the failure of different or even the same workers to obtain the same results, we have studied the summary of these investigations which was published by Henning, and computed some relative odor intensity figures, which we shall call odorome numbers. Where more than one number appears on the same line, the variations were obtained by the same worker; and where they appear on different lines, by different workers.

In this table we have chosen, for convenience, several common chemicals having the same odor intensity as our standard, and to these substances, which include amyl alcohol and ethyl ether, we have given the odorome number of 1.

Acetic acid	0.2
Acetic acid	0.0025
Acetaldehyde	1.3
Acetone	0.25
Amyl alcohol	1.

Alcohol C-7	1.
Acid C-7	3.3
Bromine	0.3
Bromine	5.
Bromoform	50.
Butyric acid	1,000.
Butyl alcohol	1.
Camphor	0.2
Camphor	63.
Clove oil	1.1
Capric acid	20.
Caproic acid	25.
Caprylic acid	20.
Chloroform	3.3
Chlorphenol	233.
Citral	2. to 10
Citral	12.
Coumarin	20. to 100
Ethyl alcohol	0.0002
Ethyl alcohol	0.004
Ethyl alcohol	0.006
Ethyl ether	1.
Ethyl ether	0.013
Ethyl disulfide	3.3
Formic acid	0.001
Formic acid	0.04
Guaiacol	0.3
Heliotropin	10. to 20
Heliotropin	100.

Hydrogen sulfide.	0.5
Hydrogen sulfide.	10,000.
Alpha-ionone.	10,000.
Alpha-ionone.	2,000.
Isoamyl acetate.	0.1
Isoamyl alcohol.	10.
Isobutyl alcohol.	1.
Isobutyl alcohol.	0.002
Iodoform.	40.
Iodoform.	166.
Lauric acid.	10.
Mercaptan.	23,000.
Methyl acetate.	0.5
Methyl alcohol.	0.0017
Methyl alcohol.	0.001
Methyl anthranilate.	167.
Musk (artificial).	100,000.
Musk (artificial).	10,000.
Musk (artificial).	1,000.
Musk (natural-Asiatic).	1,000.
Musk (natural-Asiatic).	2.
Nitrobenzene.	0.025
Nitrobenzene.	0.15
Nonyl acid.	50.
Orange oil.	1. to 2
Orange oil.	12.5
Peppermint oil.	1.6
Peppermint oil.	20. to 200
Peppermint oil.	1,430.

Phenol	0.25
Phenol	0.83
Propionic acid	20.
Propyl alcohol	0.2
Pyridine	25.
Rose oil (otto of rose)	2.
Rose oil (otto of rose)	5,000.
Rosemary oil	0.5 to 200
Rosemary oil	1,330.
Skatole	2,500.
Terpineol	0.005
Terpineol	0.04
Valerianic acid	0.5
Valerianic acid	100.
Valerianic acid	125.
Wintergreen oil	1. to 2
Wintergreen oil	110.

Divergent as these results are, they are surely interesting. They are not to be interpreted, however, as any key to the quantities of a perfume ingredient that must be used. The perfumer knows that he can use large quantities of ionone, despite its high odorome number, and only minute quantities of skatole. Such quantities are a function of the quality of the odor, the companions that one odor has with another in a perfume, the end result desired by the blender.

In this study of odor intensity, we see a beginning, nonetheless, that can lead to a less empirical approach to perfume creativity. What effect on minimum dilution or minimum

perceptibility does one essential oil have on another? Is it possible to place less than the minimum perceptible quantity of methyl salicylate in a solution already containing a given amount of geraniol and have the methyl salicylate perceived? If such were found to be the case, then the geraniol has acted to bring out what otherwise would be an odorless substance —odorless, at least, in that quantity. We would then have scientific proof that geraniol strengthens the odor of methyl salicylate. Does it strengthen other odors? Does it weaken still others? Here is practically a virgin field of research.

This, however, would not constitute a description of the odor, but merely of its strength. For the language of odor character we must still go to the vague poesy of substances that are "redolent" and "fragrant" and "smell like the honey from a bed of roses." If the scientist throws up his hands in horror, the perfumer can only say that he is at a loss for words.

CHAPTER 13

A Rose by Any Other Name

What's in a name? That which we call a rose
By any other name would smell as sweet.
WILLIAM SHAKESPEARE

THE immortal words of Juliet, standing upon the balcony and bemoaning the family feud that separated her from her lover, are provocative to the student of perfumery.

There is no such thing as a true odor of rose, J. C. Sawer points out in *Rhodologia*. Sawer claims that there are roses with fruity odors, others with the scent of violet, others that smell of musk, of bugs, and of coriander. Take a rose, even that which we usually identify with the conception of a rosy odor, and if it is called a stinkweed, many people will find little beauty in its fragrance.

Odor is a highly personal matter. By popular consent certain smells have come to be accepted as pleasant by most people. That they are influenced by name, color, packaging, associations, and by the refinements of civilization seems incontrovertible.

In order to determine whether various people obtain the same sensations upon smelling a substance, tests have been conducted in which the subjects were asked to make simple

designations describing the materials they were smelling. A few such tests are worthy of review.

Let us examine the odor classification system of Henning, which has received considerable attention from psychologists in America. His system was described in this manner by one investigator, MacDonald:

> Henning represents the odors as lying in a qualitative continuum represented by the surface of a triangular prism. At the six corners of this prism are the six principal groups of odors, which correspond to the *Hauptfarben* of the color pyramid as fundamental points of reference. At the corner of one triangular face of the prism lie the fragrant, ethereal, and putrid odors, and at the other and respectively opposite these three are the spicy, resinous, and burned odors. Along the edges and in the five faces lie psychologically simple and qualitatively intermediate odors, but the interior of the prism is hollow.

The point of greatest interest is not the method of Henning, but whether psychologically trained smellers would classify odorous substances at the same points in the prism. It was easy enough when oil of jasmin, in the studies of Dimmick, was classed as "flowery," a point at which fifteen of sixteen testers agreed. But ginger, which Henning put down as "spicy," was called "flowery" by eight, "fruity" by six, "resinous" by six, and "spicy" by only five. Odors like turpentine, glue, and hydrogen sulfide were agreed upon by most of the testers, but oil of citronella,

the well-known mosquito repellent, was placed at every point on the Henning prism except foul, and even tar, than which there is probably nothing more burny, was not put in that class by two smellers.

At Harvard University, A. Elme Findley, making similar tests, came to the conclusion that the "qualitative similarity of odors is very variable." No great degree of precision could be attained in verifying Henning's system.

J. H. Kenneth at the University of Edinburgh conducted tests that are among the most interesting in the realm of the study of odor preferences. He worked with sixty-three students, and they smelled materials as varied as carbon disulfide, cloves, menthol, camphor, lavender, rose, citronella, and asafetida. They were to smell from the bottle without looking at it and no attempt was made to identify the odor. They were asked merely to put each odor into one of four rather simple classes, based on their personal reactions: a material was either entirely pleasant (++), not entirely pleasant (+−), not entirely unpleasant (−+), or entirely unpleasant (−−).

The tests showed that a certain degree of uniformity can be attained, but it is very limited. Carbon disulfide was unpleasant to everyone who took a whiff. Rose and orris were found to be pleasant. But the large majority of substances were classified all along the line. Two examples of variations in odor reactions will suffice:

	++	+−	−+	−−
Musk	22	35	21	12
Camphor	26	37	14	5

Even more interesting were the variations from the generally accepted norm. Asafetida, whose very name is derived from an odor that is fetid, was found to be entirely pleasant by two observers.

Sixty-three subjects make an interesting beginning but are far too few for any significant conclusions to be drawn. A study of this sort raises questions that could be touched upon only rather superficially, regarding preferences by sex, by age, by family background, by racial and national origin, by color; preferences according to the time of the day, the vigor of the whiff, the condition of the observer's health, and even the extent to which he is able to discern various colors.

Albinos, Kenneth claims, are entirely devoid of the power to distinguish smells. Among his sixty-three men and women, he found that the two who cared for asafetida also liked the ill-smelling ferric valerianate, as well as the much more pleasing amyl alcohol, and the rather pleasant oil of sandalwood. Both of these people, further study revealed, were green-red color-blind!

Odors bring up associations, colors, sounds, words, images. Camphor suggests moth balls to one and camphorated oils to another, and because of the varying associations, it is pleasing to one man's mind and distasteful to the second. For Baudelaire, there were "*parfums frais comme des chairs d'enfants.*" People have extreme likes or dislikes for such familiar smells as that of the garage or the hospital.

The chemical constitution of our perspiration, which changes as we grow older, gives the caprylic or goaty smell

to the adolescent, and one could not expect a young boy or girl to have the same reactions toward other goaty fragrances as has the older person.

The literature of perfumery is filled with stories about the effect of associations on perfume tastes. Water has been tinted with odorless dyes, given a label, and placed in a perfume bottle and passed around. Very few said they could smell nothing. Some, though not many, remarked that the odor was too faint to describe, but most said it was sweet, pleasant, fragrant, flowery, depending on the color and the association. Making allowance for the odor of one's own hand and the smell of the outside of the bottle after it has been handled by several people, it is still evident that the color and the packaging suggested a smell that was not present.

It is difficult to obtain the same odor reactions from substances having different colors. The writer recently conducted an experiment along this line. The contents of a bottle of perfume were divided into three receptacles. One was allowed to stand with its original amber color; a second was made brown; a third red. Twenty-five people were asked to state their preferences and comments.

Only one person could find no preference at all, and one other person, though making a choice, declared that all three had the same character. Two people found that two of the three odors were too similar for differentiation—but they did not choose the same combination as being similar. The remainder had definite choices. "I like A, but B is out

entirely." "A has the roundest note." "A is the least attractive." "A is too heavy." "A is too light."

Similar tests with flavors reveal the same results. Take a lime flavor, color it red, and you will find that only a small percentage of those tasting it will recognize it as lime, and not many will describe it as lemony, citric, or some other closely associated flavor. Then, when the same flavor is taken a few days later and in its limy green color given to the same people, the number recognizing it almost approaches unanimity. When a worker at the Virginia Dare Extract Company took an orange flavor and gave it a cherry color and had forty people taste and see it, ten called it a "cherry," eighteen more identified it with another red taste (raspberry or strawberry), and only five called it "orange," with one naming "lemon." The other seven had reactions that can be accounted for neither by the taste nor the color.

A little light was shed on the relationship between odor preferences and association in a study made by F. Aumueller. "Jasmin and heliotrope, which are rather old fashioned flowers, have a decided preference among older persons," he found, disclosing that only 38 per cent of his subjects showed a liking for jasmin, the remainder being neutral, disliking it, or failing to reply. "On the other hand, chocolate is best liked by the youngest age group," he continues, and the preference for this odor requires no further explanation. Gasoline found greater preference among the youth. "Evidently the youngest generation, raised with the automobile, has learned to associate the odor of gasoline with good times."

The associations that are linked with odor preferences—the power of suggestion which plays havoc with the human mind—all seem to point to these reactions as something developed by environment and changing with time. There are fashions in odors, influenced by historical, economic, and geographical phenomena.

The above-mentioned Kenneth, leaning to heredity as an explanation for odor preferences, says that "observations on animal behavior, as well as medical experience, and the history of perfumery, furnish further abundant evidence of inborn (racial) likes and dislikes to odors or of required predilections."

Many workers in the field of modern psychology do not seem to agree with this statement. The smells that are generally associated with the idea of repulsion were not disliked at all times by all peoples in human history. From the day of the birth of an infant, a great pressure is exerted by civilization in formulating his likes and dislikes. His sense of smell plays an important part in his first and most important infantile sensations. His contact with the world is primarily that of taste, smell, and touch, with the development of the importance of sight and hearing to come later.

All this is put away deeply into the unconscious. In our everyday language, it is said that it is all forgotten. The individual grows up, his sense of smell is dulled, his tastes are formulated, and he finds, among other and more important sensations, that he is more fond of lavender and less of rose. He does not know why, nor does he particularly care. But if one could delve into every minute detail of the

individual's life, it is possible that reasons for individual aesthetic preferences could be found. In support of Kenneth's assumptions of inborn likes and dislikes the evidence is not too abundant.

Despite the personal variations that investigators have found, perfumery is fortunate in that there is considerable agreement as to what constitutes a pleasing odor. Like any other field of aesthetics, there is no arguing with an individual's taste. The perfumer must accept it and cater to it. He must, and does, utilize the suggestivity of a beautiful package in creating the atmosphere for a beautiful odor.

The perfumer watches the agreements and disagreements on odor preferences, delves into them, and utilizes them in creating and marketing his product. The psychologist watches them, delves into them, finds therein a field for absorbing study, and utilizes them in the search to discover what makes people tick.

CHAPTER 14

Children of Aphrodite

Love, that is crimson, sumptuous, sick with perfume,
No other words but words of love, no other thought but
love.

WALT WHITMAN

AT various times of the year, as gift-giving holidays approach, the advertising columns of the newspapers take on a changed aspect. The flights of fancy of the copy writers have no limits. The lady is exhorted to use a drop of an odor that will bring back the precious moment of an exotic night . . . the enchantment of seductive shadows . . . the glamour and the heart throbs and the maddening joys of the pleasures of the senses. The only scent . . . for the only one. The perfume that will give the body the charm of an Egyptian princess . . . the allure of a faraway star on a dark but moonlit night. One breath . . . and then a black-out of all reason. One breath . . . and then the endless embrace . . . in a full-page ad in the Sunday papers.

This approach is not meant to be literally interpreted. The writer does not believe—and does not expect the

reader to believe—that a charmless girl, if such there be, is magically transformed into something irresistible by the most remarkable perfume on earth. The advertising man who creates this copy, however, whether knowing it or not, has strong psychological support for his thesis. The linkage between odor and sex is not an invention of space salesmen or of poets. Odor has been a factor, in animal life and in man, in the choice of mate and in the gratification derived from this source.

The history of the animal kingdom is filled with stories of odor in a procreative role. Among various animals smell is the most important means of finding the mate, and from the smell the mates derive the greatest pleasure. We have already mentioned the sexual role of musk as an attractant, to which we will return shortly. Among many insects, writes Caufeynon, odor makes possible the continuation of the species, by aiding the tiny animals to seek their mates, too small to be found merely by the sense of sight.

The entire role of odor in animal life is a special study in itself, which we are touching only insofar as it throws light on odor in the life of man. In the sex life of man the factor has diminished to a point of relative unimportance but has not disappeared. In primitive man it was stronger, more potent.

Ben Jonson, in his poem "To Celia" (we are all familiar with the first line, "Drink to me only with thine eyes"), recognized the relationship between love and the sense of smell:

I sent thee late a rosy wreath,
   Not so much honoring thee
As giving it a hope that there
   It could not wither'd be;
But thou thereon didst only breathe
   And sent'st it back to me;
Since when it grows, and smells, I swear,
   Not of itself but thee!

The sensitivity of dogs to smell is poignantly expressed by MacKinlay Kantor, who wrote of an animal's meeting with Lincoln:

I was a dog of Gettysburg. I trotted
   near the train
And nosed among the officers who kicked me
   to my pain.
A man came by . . . I could not see. I
   howled. The light was dim,
But when I brushed against his legs, I
   liked the smell of him.

A number of investigators have studied the role of the sense of smell in bringing forth sexual excitation and of its contribution in the choice of human mates. Our contact with the outer world is possible only through our five senses. The love that arises in one individual for another comes only through the thoughts, knowledge, and emotion that are transmitted by the senses of sight, hearing, touch, taste, and smell. Of these taste can be eliminated as a negligible

factor. Smell, secondary in man and some other higher animals, never ceases to be of interest.

The modern salutation of greeting among individuals intimately acquainted with each other, which among adults is confined largely to members of opposite sexes, the kiss, has taken the form, in many countries, of a rubbing of the noses. In these lands such an act is a means by which two individuals smell each other, in much the same way as two animals do, in greeting each other. The word "kiss" itself in many languages is associated with the words "to smell."

From the beginnings of perfumery, musk and other animal odors were regarded as being ambrosial in character. The Chinese thought such an odor helped to arouse the latent desires of man. Oil of rue was at one time recommended to be taken internally as an aphrodisiac.

Among primitive peoples, where the delicate and refined bouquets of modern perfumery were unknown, the natives used various odoriferous substances to adorn the body. The Samoans wore garlands containing, among other plants, some ylang ylang. When a woman of Swahili wishes to make herself desirable, writes Havelock Ellis, "she anoints herself all over with fragrant ointments, sprinkles herself with rose water, puts perfume into her clothes, strews jasmin flowers on her body as well as binding them around her neck and waist." The ways of woman do not change. Today milady binds no jasmin flowers around her neck. She does not have to. She can utilize a drop of essence on her handkerchief for the same effect.

It is regarded as a natural part of a woman's self-adornment to embellish the aroma that surrounds her, just as she would use cosmetics, pretty dresses, and hair styles to appear attractive.

Yes, our sense of smell is weak compared to that of a bee or a bloodhound. Not so among all peoples. So highly developed in this sense among certain Asiatics that race and sex are recognizable exclusively by odor perception. There are cases on record of men who were disclosed as foreigners by natives; or women, disguised as men, being unmasked because odor gave a lie to their masquerade.

Some interesting work has been done on the odor perceptivity of blind people. Deprived of one of their senses, would they be forced to develop smell to a higher degree? The answer seems to be in the affirmative. A blind deaf-mute has been known to identify persons by their smell. All this adds up to a psychological potential of greater smelling abilities in man, but without some force of necessity the development of the powers of this sense is accomplished only to a small degree and with some difficulty.

Most of us are unconscious of any association between odor and sensual excitement. We are attracted to one of the opposite sex, we believe, for reasons remotely different from odor, and we seem satisfied only if the person is not ill-smelling, or if the fragrance blends into a general aesthetic attractiveness, without being specifically chosen to arouse otherwise dormant instincts.

In the realm of the unusual, odors come forth as part of the development of animal instincts. The smell of leather,

known to be a stimulant for sex among many people, is modified and beautified in a refined manner and becomes the base of one of the most popular of modern perfumes. Others find excitement in a tobacco breath, or in gasoline and other pungent odors. The success of the perfume known as *peau d'Espagne* is based on a simulation of the odor of human skin.

The reason for the minor role played by smell in the sex life of man is attributed to the diminished acuteness of this sense. It fails to act, except on close contact, and fails entirely to differentiate from one individual to the next. "But the latent possibilities of sexual allurement by olfaction," writes Ellis, "which are inevitably embodied in the nervous structure we have inherited from our animal ancestors, still remain ready to be called into play. They emerge prominently from time to time in exceptional and abnormal persons."

In the sexual life of the individual, all the pleasures of the senses are awakened. Perfume plays a more intangible, but not less real part, because it can be neither seen nor touched. The perfume of today neither magnifies nor nullifies the odor of the body. It is not meant to create the illusion of a different body odor, any more than the lipstick is meant to be mistaken for the natural pigment of the lips. It is meant only to create a pleasing odor of its own—for modern man, an improvement over nature. It is a continuation, though a refinement, of the disdain that the tribal chief had for the woman of whom he said, "She does not smell!"

Modern perfumery utilizes the imaginative powers of man, the refinement of civilization, and the strength or at least the latent ability of the sense of smell as part of our sex life. The aroma calls into being all the pleasant memories of the senses. It brings forth the happiest moments of imagination in the individual. It has an inexpressible fascination rooted in the realities of natural desires and diverted into the channels of created scents.

The deep psychological effect of odors on the lives of people has been closely associated with the use of perfumes in medicine. "Man uses perfumes to impart energy to his passion," wrote Bernardin de Saint-Pierre, to which Féré, in his study, *Work and Pleasure*, epigrammatically added: "But perfumes cannot keep up the fires which they light."

The association between musk and sex was recognized at an early age. Mohammed, who loved perfumes, singled out the musk above all. His followers called it "the noblest of all perfumes . . . that which provokes most to venery." That musk was meant to have a sexual significance to animals is seen by its role in nature, where it is used as an attractant to the mate. The musk odor develops not only in the animals where it is found useful for man, but in many others, where it is several times stronger in the mating season, such as in the sphinx moth, the lizard, the crocodile, and even the elephant.

In *The Origin of Species*, Darwin comments on this heightened odor at mating time:

> During the breeding-season the animal scent glands of snakes are in active function; and so it is with the same glands in lizards, and as we have seen with the submaxillary glands of crocodiles. As the males of most animals search for the females, these odoriferous glands probably serve to excite or charm the female, rather than to guide her to the spot where the male may be found. Male snakes, though appearing so sluggish, are amorous.

"The development of these organs," states Darwin in another passage, referring to scent glands, "is intelligible through sexual selection, as the most odoriferous males are the most successful in winning the females, and in leaving offspring to inherit their greatly perfected glands and odors."

The relationship of perfume to sex is not a new discovery. It dates back to Cleopatra, and probably earlier. Poets all through the ages, in every land, have sung of the sweet smells of their beloveds. Not a poet of any significance overlooked odor. "Her mouth is fragrant as a vine," wrote Swinburne, and in America, Nathaniel Hawthorne penned: "With that rich perfume of her breath, she blasted the very air."

Down through history, whether we look at periods when perfume was used primarily by men, by women, or by both, the special significance of odor in stimulating love for the opposite sex was never forgotten. The names of perfumes, when they were not derived from flowers, or from historical

events (such as the Guillotine at one stage in French history), were always suggestive.

At the bacchanalian festivities of the Greeks, in the excesses of the Romans, in the courts of the Bourbons, perfumes were used to attract attention, to gain favors, to induce, and to seduce. In a pre–Civil War book on perfumes in America, the odors of amber and musk are classified by the author as "stimulating."

Kiss-Me-Quick was a name given to a perfume here in America, not in the gay twenties, but long before the turn of the century. In *Harper's Weekly* it was advertised by Eugene Dupuy, transacting business on lower Broadway in New York City. His copy writer was not too subtle. Advertising his Hungary water, he wrote:

> At the present time, it has fairly eclipsed the other odorant waters, and that simply from the fact that Hungary water contains a small portion of Rosemarinus, of which its fragrant competitors are destitute. Now as it is certain that Rosemary has the power to increase the memory and invigorate the brain, as noted by the Bard of Avon, "There is Rosemary, that's for Remembrance," we can not be surprised to learn that Orators, Clergymen, Lecturers, Authors, Poets, give it the preference.

Rosemary, of course, does not aid the memory, any more than sarsaparilla purifies the blood stream, or a magic ointment cures everything from athlete's foot to ptomaine poison. The doctor who reports arousing the passions of a

man of eighty with odorous substances must give us more information before we can base a new theory of odor (or of sex) on his experience.

There is, however, in an odor pleasing to a person an appeal to that individual's aesthetic temperament. Aroma is beauty, and beauty is the stimulant to passion. It matters not what anthropological reason there may be for a man's sensations, or how much they may deviate from a norm. A man who finds in scent an undeniable suggestivity of warmth is merely utilizing one of his senses, one of his means of communication and reception. He needs more than fragrance to give him gratification, but when he has the perfume and his love, then he knows that this is the precious moment for which a man is born to live.

CHAPTER 15

Oils for Body and Soul

Here is a symbol of the material value of spiritual things. If we washed our souls in these healing perfumes as often as we wash our hands, our lives would be infinitely more wholesome.

MARY WEBB

THE medicine man appeared on the scene at the very dawn of civilization. Man learned to soothe his bruises, to place clay on his wounds, to put saliva on his cuts. He sought to relieve pain, to postpone death. He elevated to a high post in his tribe the specialist in the art of medicine, and believed that his doctor possessed occult powers.

The primitive physician was the primitive priest, and the priest, as we have seen, offered incense to the gods and became the first perfumer. Thus in their origins the art of perfumery and the science of medicine were wedded in a single man. The temple was the clinic and the perfume shop.

There was much magic in the healing methods of these priests. They claimed that the ailing had the devil in them and they invoked all sorts of wordly and spiritual methods to drive out the evil demon; on the poor victims, they used grimaces, frightening noises, whippings, and horrible odors.

They hoped that these odors would be as obnoxious to the devil as to man and that the evil spirit would depart from the patient's body. Not a very pleasant therapy for the patient, this healing in which odor was already playing a part.

In Egypt, where we find the first record of organized medical practice, pleasant-smelling perfumes were part of the wares of the physician. In one papyrus there is found this incantation, a prayer to be given with the remedies: "Welcome, remedy, welcome, which destroyest the trouble in this my heart, in these my limbs. The magic of Horus is victorious in the remedy." Cosmetic and perfume preparations were part of this magic.

In 1552 B.C. the Therapeutic Papyrus of Thebes was written. In addition to sections on tumors, pediatrics, and gangrene, there were cures for freckles and wrinkles, and perfumes for aromatizing the clothing and the breath of the users.

In the Scriptures, Jesus cleansed the leper with an essential oil, the spikenard, and in the Greek mythology the physician, Apollo, healed other gods by the use of peony root, and treated his dying love, Coronis, by pouring perfumes over her breast. Coronis gave birth to Aesculapius, who followed in his father's footsteps and became the greatest of medical men, curing the ills of mankind by beautiful sights, pleasant surroundings, music, and fragrance.

Early prescriptions and formulas are filled with references to essential oils and perfumes. The medicine man was not only the priest, but among the polytheistic tribes he was the

witch doctor. His cures were magic, faith, accident. He attributed to all sorts of animals and plants great healing powers. He used herbs, roots, petals, the bark of trees, anything that grew, anything that smelled. He little realized that he was stumbling across a great group of valuable medicaments, widely distributed in the vegetable kingdom, the alkaloids, and that he was confusing the therapeutic values of these materials with those of the essential oils.

Some of the cures attributed to the perfume oils were later to be abandoned as being unfounded in science. Some patients recover through natural processes, and the early doctors hastened to account for the recoveries in any possible manner. If perfumes were used, and the patient lived, then perfumes were cures. The pleasant odors induced a restful state of mind among the ailing.

Some cures, on the other hand, were later to be justified scientifically, and if in recent years they have been left behind by the great advances in medicine in the twentieth century, they nonetheless made a contribution to the historical development of the science of the physician.

Many of the medical uses of the volatile oils are centuries old. Oil of savin was used in Roman medicine. The Egyptians used cedarwood in embalming the dead. Saffron and calamus were widely mentioned in the medical tracts of antiquity. The Arabian physicians used an oil with the melodious name of "galangal," and a German university to this day possesses a prescription, written in the eighth century, which carries this oil as one of the ingredients.

Oil of rue was used in the treatment of diseases of the eye,

for which purpose it was described by such illustrious writers as Pliny, Ovid, and Discorides. As late as 1892, German physicians reported success with oil of cypress in the treatment of whooping cough.

An account in the United States Dispensatory tells of the value placed upon musks by doctors in former years:

> By the preceding generation of physicians, musk was one of the most highly esteemed remedies. . . . It was attributed with remarkable restorative powers in the nervous exhaustion of low fevers, such as typhoid or pneumonia. It was also highly esteemed for its antispasmodic action, especially in hiccoughs and in laryngysmus stridulus.

If the reader stops a moment at this passage, let him be reminded of a remark in Plato's Dialogues: "They do certainly give very strange and newfangled names to diseases."

Even in war medicine, the physicians did not overlook perfumes. Ambroise Paré, well-known surgeon of the sixteenth century, described his work at the scene of a battle:

> I put in each wound a tent. . . . The said tents were anointed with a medicament made of the yellow of eggs and Venice turpentine, with a little oil of roses.

Essential oils were used internally; they were employed on the skin; and, reverting to their genuine purposes as odorants, their vapors were inhaled in the treatment of respiratory difficulties, such as asthma, bronchitis, and

whooping cough. Several oils were recommended for diphtheria; wild thyme was used for pulmonary disorders and for bronchial and lung troubles. In nervous disorders, in venereal treatment, in gynecology, and in obstetrics essential oils have found a place.

Summarizing some of these outstanding uses of the oils, Albert Jentzer, in his book, *Traitement biologique des infections*, mentions, among others, oils of savin, thuja, pennyroyal, rue, and arnica, as having been employed as uterine stimulants and for other gynecological purposes; oils of juniper berries, parsley seeds, jaborandi leaves, lovage, sassafras, sandalwood, angelica roots, and balsam copaiba have been known as diuretics; others as diaphoretics, vermifuges, excitants, sedatives, and carminatives.

This particular author has loudly proclaimed a mixture of essential oils, which he terms "themsaline," consisting of oil of pine needles, camphor, cinnamon, balsam Peru, elemi resin, and thymol, and cites case histories of the success of this mixture in a long list of ailments ranging from dental swellings to incipient peritonitis.

Investigators have turned to essential oils and perfume chemicals in the hope of finding cures for the most dreaded diseases of mankind. Thymol and guaiacol have at one time held out some promise for tubercular infections, and among the many roads that research workers have followed in the search for cancer cures one finds experiments with the synthetic aromatic, heptaldehyde. One of the few hopes for a leper whose disease is recognized in time is found in oil of chaulmoogra.

A glance through official compendiums and modern medical volumes will demonstrate that essential oils have not been abandoned by the medical profession, and that many aromatic chemicals are used both in perfumery and in medicine. The National Formulary and the United States Pharmacopoeia to this day contain monographs on menthol, eugenol, vanillin, camphor, benzaldehyde, anethole, thymol, and numerous other substances, as much a part of the shelf of the pharmacist as of the perfumer. The United States Dispensatory summarizes some of these uses:

Oil of anise stimulates peristalsis in colic, and has been used as an expectorant and in treatment of scabies.

Bergamot, which one would scarcely expect to find on a doctor's list, has been used to protect the body against lice.

Cajuput oil is a stimulant and expectorant, and has been used for such diverse ailments of the body as rheumatism, laryngitis, toothaches, and scabies.

Chenopodium, it is claimed, has value against hookworm and related ailments.

Cinnamon oil has been prescribed in gastric difficulties.

Eucalyptus oil, in addition to being a stimulant, has been used for chronic bronchitis.

Camphor has long been employed as a heart stimulant.

Lavender, it is claimed, has carminative properties.

On and on the story continues. Rosemary, sassafras, sandalwood, galbanum, and even ambergris find mention, and among the ailments for which they bring relief are those attacking the skin, stomach, throat, intestines, and other parts of the body.

Many of these cures have fallen by the wayside. A few have survived the test of time. Those which are of greatest interest to the medical profession can be placed in the following few categories:

Germicides. It was found in the early investigations of essential oils that most of them were rather powerful germ killers. The bacteriologists are wont to express this germ-killing power in relative terms, as related to carbolic acid or phenol. This germicidal power varies, as would be expected, under different conditions and against different types of bacteria. The relative strength, expressed as what is called the "phenol coefficient," is an index of the bactericidal or germicidal power of a substance, and when it is high, that substance may find use as an antiseptic, whether in the kitchen or the surgeon's office.

Judged in this manner, the phenol coefficient of thymol is generally agreed to be about 25. In other words, it will require only 1 gram of thymol to kill the same amount of certain bacteria, under similar conditions and over the same period of time, for which 25 grams of phenol would be needed. Geraniol, menthol, citral, cinnamic aldehyde, and scores of other perfume oils and synthetic aromatics are shown to be more efficient germ killers than carbolic acid.

Venereal Treatment. The germicidal properties of the essential oils are largely related to their general and specific uses in medicine. As bacteria destroyers, several of the oils were used for the treatment of gonorrhea and for other ailments of the genitourinary tract. It was but yesterday that physicians depended on sandalwood oil and balsam copaiba

in treating gonorrhea, one of the most widespread of the so-called "social diseases."

Scabies. Some say that the Greeks had a god of the itch, whom they called Scabies. The lexicographers give us a less romantic origin of the word, but the disease is nonetheless repulsive. Little tenacious mites attach themselves to the skin, particularly in hairy parts of the body. They are easily passed from one person to another; they thrive in dirt and filth; and so serious are they in wartime that scabies has been called an "occupational disease" of soldiering.

The suggested treatments of scabies have been numerous, and one that has been widely accepted in recent years is based on benzyl benzoate, a synthetic well known in perfumery as a solvent.

Hookworm. Hookroom is among the great scourges of mankind. In warm climates, in tropical countries, in the southern parts of the United States it attacks amazingly large numbers of victims. The worm lodges itself in the small intestine, lives there for six or seven years and lays its deadly eggs by the millions. It causes anemia, overwhelming appetite without benefit of the foods consumed, fatigue, and general ill effects to the entire body, particularly its digestive and circulatory systems.

Many chemicals for the cure of hookworm have been suggested, and while none has proved to be ideal, thymol has received as wide acceptance as any of its competitors. This substance, known for its antiseptic properties, used in soaps and disinfectants to which it aids in imparting a "hospitallike" odor, has been found to be relatively safe

and rather effective against hookworm, although it must be employed in quantities that make it expensive. The use of thymol-containing oils, widespread in medicine, is recorded as far back as 1693, when the medical practitioners were recommending oil of ajowan.

Anesthetics. Many of the essential oils have been used as local anesthetics; they include camphor, eucalyptus, and clove oils, and among the aromatic chemicals, benzyl alcohol. More efficient local anesthetics have been found for most purposes, but in dentistry clove oil, and particularly its active ingredient, eugenol, remains an effective pain reducer.

Insecticides. Closely related to the medicinal properties of the oils are their power to make the body comfortable by protecting it from the attacks of insects. Some oils are effective in repelling insects; others attract and kill them. Oil of citronella is one of the classic protectors of the body against mosquitoes, while geraniol is an important agricultural insecticide, as it attracts the Japanese beetle to a trap and death.

Inhalants. In respiratory infections, inhalants and vaporizers aid in keeping the nose and throat clear, permitting normal breathing. Menthol sticks are used for this purpose, and tincture of gum benzoin, one of perfumery's favorite fixatives, is effective when vaporized with hot water in the treatment of laryngitis and pharyngitis. Oil of eucalyptus is widely used in this manner.

Flavors. Medicines have traditionally been associated with ill-tasting substances. Many a person vividly recalls

the dose of castor oil he had as a child, a sensation as unpleasant as it was unnecessary.

A giant of medicine of the sixteenth century, Michael Servetus, lashed out against the notion that medicines, to be effective, had to be unpalatable. In his book, *Syruporum universa ratio*, he excited a storm of criticism from the conservative physicians by advocating that essential oils be used as flavoring agents in medicines; that is, even though they may be of no curative aid in themselves, they can cover up the revolting odors and tastes.

For this contribution to medicine of the Renaissance era, as well as for other minor and major heresies, Michael Servetus was burned at the stake. Today we take for granted that perfumes and essential oils have their place on the doctor's prescription. Anise, lavender, rose, vanillin, coumarin, rosemary, thymol are but a few of a long list of effective flavors constantly being used by the pharmacist.

For most of these purposes (though not in venereal treatment) the unity of medicine and perfumery has continued. But on the whole, the day has passed when essential oils are advocated for all sorts of ailments, from pneumonia to appendicitis. The perfumes that held forth great promise to medicine made their historical contribution to the development of the science, and have now been left behind by the developments of the last few decades. Today we have effective anesthetics, safe and powerful antiseptics, and the entire science of surgery, though as old as medicine itself, has made giant strides since the days of our grandfathers.

Radium has been discovered, and a new field of therapy, radiology, has been born. We have the indispensable implement of the doctor, the X ray, giving him a diagnostic weapon undreamed of when musk was being prescribed.

Today the relatively young field of chemotherapy is unfolding for medicine. This is the science of cure of specifically named ailments by specifically chosen chemicals. Paul Ehrlich was the first of the great in this field. He set out to build a molecule that would destroy the germ causing African sleeping sickness, and then, aware of a possible affinity between that disease and syphilis, he applied his 606 to the victims of the dreaded venereal scourge.

Not many years later, the powerful bactericidal value of sulfanilamide was discovered, followed by the synthesis of many closely related substances. Fortunately for man, sandalwood could be relegated to perfumery; the doctor had in sulfanilamide a far better means of combating the germs that cause gonorrhea.

Perfumery and medicine, starting from the same path, have parted company. The pharmacist is still the compounder of prescriptions and the salesman of perfumes; he is the intermediary between two industries that have lost their common ground. Essential oils that are still somewhat useful to the doctor are a hang-over from former times. Even among the antiseptics, a substance like thymol is today weak when compared to the synthetics created in the chemical laboratories.

Yet even chemotherapy was not the final word. With

the discovery of the germicidial powers of penicillin and streptomycin, man was returning to the natural sources that he had only recently abandoned, to find the most powerful germ killers of them all. He had started from nature's oils and was returning to her molds. He had started from a complex form of plant life, high in the evolutionary scale, and was returning to plants almost as low and simple as any known.

The perfumer will not regret that his products have been abandoned in the forward stride of modern medicine. He takes the same delight as does all mankind in medical progress. If there are more efficient pain deadeners and germ destroyers than essential oils, so much the better. Let the perfumes be used not for the relief of the sick, but for the stimulation of joy—not to deaden the senses to pain, but to quicken them to the loveliness of life.

CHAPTER 16

Odor Is a Big Business

In the modern world, the sale and use of perfume have reached a degree of expressiveness and refinement far surpassing that of former times, less lavish, but more individual and more exquisite.

RICHARD LE GALLIENNE

THE development of synthetic organic chemistry in the last quarter of the nineteenth century left a gap in the industries supplying materials to the perfumers. The possibilities loomed large for factories producing neither essential oils nor perfumes, but the growing variety of synthetics.

At the time, both perfumery and organic chemistry were European industries. In France, where the art of the perfumer had reached its greatest heights, the making of chemicals for their sweet smells was looked upon by some with suspicion. In this development the French saw, on the one hand, a threat to their essential-oil industries. Some men feared, and some chemists predicted, that the day would fast approach when the beautiful fields of the *Midi* would be growing their flowers exclusively for the adornment of vases in dining rooms and hospitals. And on the other hand, the perfumers of France feared that synthetics would corrupt their art.

In Germany, where Hupfeld, Baur, Reimer, Tiemann, and Kruger had made their epochal discoveries, and where organic chemistry had reached its highest achievements, the science was part of an international front of power politics. Processes were jealously guarded, production was restricted, prices were kept high, and developments were exploited for future economic advantage rather than immediate results.

It was almost inevitable that the first center of synthetic aromatic chemistry should have been Switzerland. In this little, industrialized democracy, the giant strides of organic chemistry had not gone unnoticed. At the University of Zurich professors had already won renown, and students were being taught who were destined to become world leaders in this science and industry. Switzerland, geographically, was close enough to Germany to have contact with the latter's inventions and inventors. The wide knowledge of German in Switzerland facilitated the efforts of the young Swiss chemists to follow the advances in the science, whose literature, at the time, was primarily in the German language. She was also adjacent to France and to Italy, for ready access to their essential oils and easy transport for the sale of aromatics. Finally, the new German patents, which were about to revolutionize perfumery, could find no protection among the Swiss.

By the turn of the century, at least two Swiss firms had won recognition as leaders in this field. They conducted an aggressive campaign for the acceptance of synthetics by the outstanding perfumers, not as money-saving substitutes, but as indispensable ingredients in the art of odor blending.

They sponsored research in every aspect of olfactory science. They formed a close alliance with the essential-oil producers who had, wrongly, feared them; they became large consumers of oils and they demonstrated that there was no inherent contradiction between the sale of naturals and synthetics.

By the time the First World War broke out, the industry had won wide acceptance in Europe. America, however, had been lagging behind in the development of a chemical industry. The Americans had their chemical worries with dyestuffs during the First World War. Few gave a thought to perfumery.

There were a few people in this country interested in the sale of essential oils and perfume raw materials. In 1798, there was founded a firm which has survived to this day, a well-known name and a major factor in the industry. There was even a scant literature on perfumery in America. One book on the subject appeared at the close of the Mexican War.

The first company devoted exclusively to synthetic aromatics was probably the one founded in 1899 by Alois von Isakovics, who proclaimed at Columbia University a few years later that synthetics were indispensable to every perfume manufacturer.

In the 1920's many of the already established essential-oil houses in America, most of them branches or affiliates of European companies, began to expand their activities. The Swiss aromatic-chemical firms formed subsidiaries in this country. Some of the bigger companies, making

chemicals on a large scale, began to eye this expanding field. Some thought that a big pie was going to be cut and wanted to be in at the party. Others were skeptical. The perfumers in America, they contended, would never accept domestically produced merchandise. They wanted stuff from far-off lands, exotic and with foreign names.

Making the field even more interesting were the changing mores of the American woman. During the first war it was not respectable for a lady to use perfume in this country. She hid the imported *flacon* in the same drawer with the package of cigarettes, to be used on some wild and exciting night.

The years following the armistice saw the success of the suffrage movement, the use of cigarettes by woman, her entry into politics. A respectable girl, it was learned, could go out with a man without a chaperon, could bob her hair and wear short skirts, could act on the stage, and could use perfume. And she did.

The market for perfumes grew, and even the depression years, which might have been expected to play havoc with a luxury industry, saw no slackening of the productive pace. Odor had become a big business in America.

How big a business is odor? That is a hard question to answer, but a few statistics are interesting. *Fortune Magazine* found that the American essential-oil and aromatics business, in wartime, passed the $50,000,000-a-year mark, with the scented products having a retail sales value in the billions.

In the year 1942, according to official government sta-

tistics, we sold in this country $18,000,000 worth of aromatic chemicals for flavoring and perfumery purposes, of which about half were derived from coal tar, the remainder from essential oils. This figure does not include the value of the essential oils themselves.

We produce in this country interesting quantities of sassafras oil, pine oil (part of which is used in perfumery), peppermint and spearmint, orange, lemon, and other citrus oils, wormwood, wormseed, cedarwood, pennyroyal, and other less important items. The total production of these oils in one year is difficult to compute with any great degree of accuracy, and even more difficult would be a separation between the values of the oils used in flavors and in perfumery. Nevertheless, the domestic essential oils surely have a total value of $20,000,000 yearly.

The more expensive oils are primarily imported products. In the year 1938, the last normal prewar year, we imported from abroad over $5,000,000 worth of essential oils and flower oils. Of these 39 per cent came from France, 10 per cent from the British Empire, 8 per cent from Japan and Italy, 6 per cent from the Dutch East Indies, 3 per cent from Bulgaria, and the remainder from a wide variety of countries.

Adding together, then, the $18,000,000 for aromatics, the $5,000,000 for imported essential oils, and the $20,000,000 for domestic oils, we would get over $40,000,000 worth of perfume and flavoring raw materials. There is in this figure a slight duplication, because some of the essential oils are used to produce the aromatics.

To this figure one can add the value of perfume mixtures and bases sold by those dealing in perfume raw materials. The aromatic-chemical and the essential-oil houses make up for their customers all sorts of blended or compounded perfumes. Formulas are worked out for customers from a much wider variety of raw materials, natural and synthetic, than any of the smaller consumers could hope to command. The wide experience of these companies in making up a given odor, of a certain price range and for a special purpose, is unmatched by any of the smaller and by most of the larger perfume users.

For those not actually engaged in perfumery but finding that aromatic substances are needed in their products for one reason or another, this is the only practical way of purchasing an odor. These people are little experienced and less equipped to start their own experimentation with the few aromatics that they might possess, and with whose properties they are not thoroughly acquainted. What rubber manufacturer will want to blend his own deodorant or reodorant for rubber, when he is able to purchase a finished rubber perfume, and his experimentation, if he wishes to conduct any at all, can be confined to the methods of incorporation and the amounts to be used?

One company dealing in perfume raw materials may have as many as ten thousand formulas in its possession. The formula books are hidden away at night in large safes. The shelves are lined with thousands of bottles containing small quantities of each blend or mixture that has been made up at one time or another. And with its ten thousand

formulas, the company's perfumers are constantly working out new ones.

In America in wartime, the importation of essential oils and aromatic chemicals died down to a bare minimum; the former because they were not available, the latter because they were being made domestically. In the year 1940 less than 22,000 pounds of aromatic chemicals were imported into the United States, far less than 1 per cent of what we produced here ourselves. These imports had a total value of only $59,427, a drop in the bucket on the American market. Only six aromatics were imported in 1938 in quantities totaling over 1,000 pounds for the whole year; there were nine in 1939, eleven in 1940. But none of these was any longer an item that could not be obtained on the domestic market. The importers were no doubt affiliates of the foreign makers, and were able to use or to dispose of these small quantities. Of phenyl ethyl alcohol, for instance, of which 1,010 pounds were imported in 1940, this is about one-third of one per cent of a normal year's production.

The sale of scented materials in America is something even more difficult to express in figures. The fragrance may loom as a large part of the cost of the item, or even almost all of it, as in the case of a toilet water; it may be an important factor, as with soap; or it may amount to but a small part of the value, as with women's scented lingerie.

The production of perfumes, cosmetics, and toilet preparations in 1939, not including soap and shaving creams containing soap, amounted to a value of 157 million dollars,

judged at the point of manufacture. Of this, 8½ millions were ascribed to perfume. Add the cost of freight, the wholesale and retailing handling charges, and the figure rises to about a quarter of a billion.

Another 292 millions can be added for soaps of all kinds, and a much smaller figure for household disinfectants containing aromatics. Adding together all these figures and translating them into consumers' prices, we have easily reached the billion-dollar mark, and we have not taken into account the whole field of flavors, medicines in which aromatics are used, baby oils, and other types of perfumed products.

Taken at the consumer price level, the trade publication, *Drug Topics*, states that in 1943 civilians purchased some $98,000,000 worth of toilet soaps, $48,000,000 worth of cold creams and cleansing and all-purpose creams, $17,000,000 worth of hand lotions, $4,500,000 worth of hand creams, $1,500,000 of protective hand creams, $5,500,000 of baby oils, $64,000,000 worth of dentifrices, $17,500,000 of mouth washes and gargles, $20,000,000 of shampoos, $13,500,000 of hair tonics, $89,000,000 of home insecticides and disinfectants, $15,500,000 of deodorants. It sounds like lots of millions of dollars. These figures, all of which cover items that contain some perfume materials, total almost $400,000,000, and the figure does not include perfumes and toilet waters themselves, flavoring materials, and the very real value of materials sold to the Army, Navy, and post exchanges.

Another business publication, *Soap and Sanitary Chemicals*, in an article by C. W. Lenth, estimates the 1944 production of toilet bar soap at half a billion pounds, of shaving soaps and creams at 25 millions, of liquid soaps at 50 millions. All of these types contain an interesting percentage of perfume, and a small amount of perfume is no doubt used in the upward of 3½ billion pounds of other types of soaps, such as laundry soaps and washing powders, produced in that same year.

It can readily be seen that, when discussing a product that is made in billions of pounds, and which consumes essential oils and aromatic chemicals, the use of perfumery materials runs into a large figure for the soap industry alone.

How widespread is the use of perfume itself in America? That perfumery is accepted by all, and used by many, is undeniable. In its Tenth Survey of Beauty, the Market Research Department of Modern Magazines found that, as far back as 1940, almost three out of four female adults in America used perfume of one type or another, the proportion going as high as four out of five among the youth near the age of twenty.

The industry is big, and getting bigger. The dominant place in the field still belongs to the old American and European essential-oil and aromatic-chemical houses, almost unknown to the public at large and comparatively unknown even within the realm of organic chemistry, except to those particularly interested in odorous materials.

It can be said that the largest chemical companies in

America are not an important factor in the industry; one of the very few branches of chemistry in which they play such a minor role. They are not accepted by the thousands of users of perfume materials. The methods of large-scale organic chemical manufacture cannot easily be transferred into the field of aromatics. The final test is that of odor, not of physical or chemical properties, and to meet that test requires years of patient experience; requires an enormous amount of good will and customer confidence.

The methods, experience, and approach of chemical big business are not suited for a science that is at the same time an art. The large firms have a prominent place in the field only as manufacturers of a few aromatics that happen to be large-volume items; but that is primarily because such products can be handled on an industrial scale.

The firms now enjoying a privileged position in the industry have won their niche by experimenting with tens of thousands of formulas, by devoting themselves to the study of essential oils and aromatics, by building up new specialties and bases that have a unique place in the trade, by rounding out a list of the better known aromatics and essential oils with a list of hundreds that are known little and used less, and that they make in quantities sometimes as small as a few ounces at a time.

The industries that these companies serve find that formulas cannot be written down and mechanically copied. They find that the European productive methods, which made a contribution in the field of pharmaceuticals and dyestuffs but which could then be discarded in favor of our

own advancements, had an intangible contribution to make in a fineness of odor, a perfection of blended scent, a knowledge not easily recordable. Though America now has its dominant place in the production of aromatics, it is a big American industry where the European influence is strong and beneficial.

CHAPTER 17

Living in a Perfumed World

We live in a world of odor, as we live in a world of light and of sound.

H. ZWAARDEMAKER

FROM dawn until twilight and long into the night, from the cradle of the infant to the silence of the grave, we are surrounded by odorous materials. Perfumes in one form or another are a part of the things we see, touch, eat, wear—and smell. We take our odors for granted, and little realize how much we would be affected if our lives were deprived of perfume. The days of perfume orgies are over, but more perfume is used today than ever before, with the end not yet in sight.

Probably the largest consumer of perfume in the world is the soap industry. We come in contact with soap from the moment we arise in the morning until we retire. It is one of the primary necessities of a civilized nation, for the promotion of cleanliness, the fostering of beauty, the protection of health.

Yet, ask the man on the street if he likes to use perfumed soap, and he will probably look at you a little queerly. Give

him two bars of soap, one containing a pleasant though not too strong aroma, and the other no odorous substances, and there is no question about his choice. He likes the pleasant smell on his hands, face, body. He does not know that all toilet soap is perfumed, whether the fragrance be one that is like the garden or forest, or reminiscent of a hospital room, or whether it seems merely to neutralize the fatty odor of the soap itself.

Nothing could be more misleading than the popular misconception that the manufacture of aromatic materials is primarily for a lady's perfume. Perfumes are found in ointments, creams, cosmetics of all types, flavors, insecticides, tooth pastes, and in literally thousands of other types of products.

Perfumery is the science and art of odor. It is concerned with the creation of new odors, the duplication of others, whether they be from nature or from the laboratory. It changes the odors of materials, usually to make them smell more pleasing, sometimes to abolish the smell entirely, and sometimes to make it quite obnoxious.

This may sound strange. Perfumery concerned with the creation of an obnoxious odor? Yes, odors must be added to toxic gases so that you will receive a warning that gas is escaping. The nose learns about the gas before the body has been affected. The chemist, searching for the right perfume, had to find material that could be mixed with this gas and having an odor that would be "characteristic." It had to be an odor not encountered elsewhere. The science of odor creates stenches in the kitchen and stenches in the

mine, and then turns around to abolish the smells that had already been there.

Perfumery has had its fashions, and we seem, at this moment, to be emerging from a period when they were confined largely to the female sex. In most lands where the art has flourished almost from the dawn of civilization, this has not been the case. Even today, however, there is more male prejudice against the word "perfume," representing as it does the suggestion of a fragrance that is strong and effeminate, than against the idea of perfume for men.

Large numbers of men use after-shaving lotions and hair tonics, where the perfume is one of the chief functions of the material. Under another name, the perfume for the male has a bright future in America. The term "man's cologne" is frequently employed in this connection; or perhaps the name will be "shave water," or some other appellation not yet discovered. There is not a shaving cream that could be sold to a man without perfume in it. Every man has a sensitive nose, and it likes to be pleased.

A large number of products coming from the factories of the country are unpleasant in odor, a characteristic that is a handicap to their use. Many types of synthetic rubber must have the odor changed, if this rubber is to compete successfully with the natural kind. Odor of an unpleasant type in a rubber toy, rubber sheet, garden hose, rubber gloves, and almost anything else made of rubber would be a great deterrent. But the synthetic-rubber industry need have no fears, for perfumers have done wonders in changing rubber smells.

Some types of plastics must have an odor transformation. But the possibilities in changing odors are much greater in the fields of varnish, printing ink, paint, shoe polish, floor covering, floor polish, coated paper, synthetic fiber, and the thousands of finished consumer goods made from such materials.

The odor of most types of glue is one of the least pleasant to the human nose. In years to come, when manufacturers will have to find appeal for their products to meet competition from home and abroad, deodorized glue—even fragrant glue—may become nationally accepted. The smell of a house being painted and that of a newspaper being read can stand great improvement. No woman wishes to wear a girdle or a brassiere made of ill-smelling textiles.

There is an odor that we associate so closely in our minds with shoes being polished that it is almost a trade-mark of the shoe-polish industry, but it is a smell that can stand great improvement. A house or office can be painted without the unpleasant stench that usually does not disappear for several days.

The transformation of these everyday commodities into fragrant materials, as pleasant as a garden bed in spring, is one of the postwar promises that chemistry holds out for the world. It will be part of the world that will have suits that will not crease, woods that bend like bamboo, autos that go fifty miles on a gallon of gasoline, and pleasant smells all around us.

The agriculturalist uses odors to protect his crops. It is found that some odors repel dangerous insects while others

attract them. Attractants can be mixed with poison or can be placed in a trap, while repellents are used to make our lives more comfortable by driving away mosquitoes and other pests. These insects, with their little sensory organs, are excellent smellers. Some chemicals that do not seem to possess any odor at all, according to man's nose, have a smell strong enough to drive insects away.

This distaste that some forms of animal life show for certain smells was put to excellent use during the war. "Naval researchers first noted," a newspaper item in a business paper recently stated, "that live sharks avoid water where dead, decomposing sharks are found. On further investigation, they discovered that it was the odor which scared off the sharks. Chemists then worked on the problem until they duplicated the essential element synthetically, with the same smell. . . . The chemicals are released in the water by a ripcord attachment. The sharks don't wait for a second smell; they go scattering in all directions."

Often the perfumer is called to work on some commercial product that the most odor-conscious user hardly dreams has had to be treated for its odor effect. Walking in and out of the laboratory quite frequently one day, we noticed the perfumer constantly washing his glasses with a little sprayer. We offered the gratuitous advice that we knew of a good washing solution, if the one he was using was not satisfactory, only to be told that he was experimenting with various types of perfumes. Who thinks of perfumery as concerned with a liquid for cleaning eyeglasses? Though the wearer may scoff at such a use and offer to buy the

unperfumed cleaner, he would find that the solvents have a disagreeable smell, irritating when the glasses are placed on the bridge of the nose.

A volume of anecdotes could be written around the problems brought to a perfumer and the unusual uses to which scent has been put. Sir Izaak Walton used essential oils on his bait; one of his modern disciples asked the perfumer if there was an odorous material that he could use to help fill the boat when he was out on a fresh-water fishing trip. (Please note: This problem has not been solved.) An insecticide manufacturer was searching for a perfume that simulated the odor of cockroaches. This was the prelude to some rather unpleasant experimentation.

Industry begins to awaken to the potentiality of "sell by smell," a slogan brought forth by an aromatic-chemical firm over a decade ago. How effective can selling by smelling be? One experiment, conducted under the supervision of Donald Laird, gave interesting results. Salesmen went from house to house with various pairs of women's hose and, making no effort to sell, they asked the women to choose their favorite pair. They were exactly the same stockings, at the same price. One lot had been faintly perfumed, the other untouched. At the end of the first day, the overwhelming choice was the scented hosiery.

When the women were asked why they had made the choice they did, they gave various reasons. Some said they liked the feel of it, the looks of it, or that they just happened to pick it, for no good reason at all. None realized that they had been attracted by the odor. The fragrance was all

the more effective as a selling weapon because it was so subtle.

Similar tests with plastic toys, rubber girdles, and artificial-leather wallets bring the same results. Even the circus has gone in for perfume. The elephant trainer sprays his gigantic animal with a pleasant deodorant.

There are few industries in America that are not consumers of perfume raw materials or perfumed materials. But every perfumer, after dabbling in deodorants and insect repellents, will wish to return to his first love. He seeks to create a fragrance that will stir the imagination of man and woman, awaken long-forgotten memories, and arouse the sensations of the most sensitive. He seeks to build fantasy upon illusion, to inspire the creative, the poet, the artist, the lover.

Perfume itself, his great achievement, is his contribution to the creation of a more pleasing world. In his perfume he blends the mystery of unknown peoples, the history of unrecorded centuries, the wonders of nature, and the marvels of science. He is the artist who synthesizes these elements into one living reality.

Borrowing from the words of Edna St. Vincent Millay, his creation becomes

> . . . a fragrance such as never clings
> To aught save happy living things.

In the accompanying bibliography a large number of valuable books are discussed, most of which have unfortunately been out of print for many years. Many of the best of these books are now available on microfilm in the Micro-Technic Library, and may be obtained from Tech Book World Magazine, Hobart Publishing Company, Washington, D. C. As we go to press with this printing, the following authors have become available in this library:

Eugène Charabot	William A. Poucher
Félix Cola	H. Stanley Redgrove
Ambrose Cooper	R. Sigismund
Horace Finnemore	J. L. Simonsen
Hans Henning	Theophrastus
Ernest J. Parry	Fred Winter

H. Zwaardemaker

APPENDIX A

The Perfumer Turns Bookworm

THE literature of perfumery is vast. It comprises tomes written for the consumption of the chemist, the perfumer, the physician, and the general public. Various approaches have led many writers into the subject of odor.

Rather than give a list of such works, we shall present a short discussion of the various phases of this accumulated literature.

The Writers of Antiquity

The subject of odor attracted the attention of many of the illustrious authors who lived before the Christian era. Of these, most prominent were Pliny, Ovid, Discorides, and Theophrastus.

Theophrastus probably lived from 370 to about 285 B.C. He was one of the great Greek botanists, and his writings constitute one of the classic pieces of Greek scientific literature. *Enquiry into Plants and Minor Works on Odors and Weather Signs* (two volumes, New York, 1916) contains the essay *Concerning Odors*, which, if translated into more modern language, in many parts would read like the work of a contemporary writer.

Even the problems of the language and the classification of odor did not escape the attention of this classic scientist: "We speak of an odor as pungent, powerful, faint, sweet, or heavy, though some of these descriptions apply to evil smelling things as well as to those which have a good odor."

Theophrastus recognized the shortcomings of the various oils that were vehicles for perfumes, and complained of their being greasy. Although he dealt with the perfuming of beverage alcohol, it never seems to have occurred to him or his contemporaries that in alcohol the almost perfect solvent for perfume was available.

Other sections of his essay deal with the medicinal value of perfume, the odor of animals, and the relationship of odor to taste and to the other senses.

The Historical Literature

Every branch of learning produces its outstanding historian. Perfumery is no exception. The man who recorded its story was Eugene Rimmel, a perfumer doing business in London in the middle of the nineteenth century.

The Book of Perfumes (London, 1865) is not merely a delightful history of the art, readable to this day. It was the spadework and groundwork for all future books on the history of pleasant-smelling substances. It is well documented, interestingly written, and abounds in poetic quotations. The reader today can only regret that Rimmel had a second love. Besides odor, he was interested in hairdressing, and, like a subtheme, the history of hairdressing interferes with the story of fragrance.

One of the contemporaries of Rimmel was the colorful figure of G. W. Septimus Piesse, whose *Art of Perfumery* (London, 1855) became a classic in the literature. Most of this book deals with the ingredients of perfumes; a part of it is historical. It was no doubt one of the first intelligible and well-written authoritative studies of its type, by a man who did his utmost to popularize his art and to place it on a scientific level. Piesse won for himself an international reputation that has survived to this day, but his book, though often referred to by later writers, has outlived its usefulness.

An unusual book of great historical value is *La Parfumerie française et l'art dans la présentation* (Paris, 1925). The book is the work of several authors, and was published by a well-known trade journal, *La Revue des marques de la parfumerie et de la savonnerie*. It is a magnificent presentation, unequaled in the literature, worthy of all the art that has gone into perfumery and all the effort that went into the preparation of this volume.

This tremendous book, profusely illustrated, contains illustrative and textual matter on the history of perfumery, with particular attention to the evolution of the *flacon*, and to labels, ancient and modern. Other subjects include Grasse and the cultivation of its flowers, and a detailed study of the origin of eau de Cologne and the juridical disputes of the Farina family. In short, this is one of the great books of the industry.

The same publication also edited and published *Grasse et sa région* (Paris, not dated) likewise a beautiful piece of

work, although smaller and less elaborate. The material is devoted exclusively to the story of Grasse, its history, industries, people, flowers. It is valuable in the study of French perfumery and the French floral-oil industry.

Published by this same journal were several other volumes that present the artistic, industrial, and scientific aspects of French perfumery. They are: *Entre le champ de fleurs et le laboratoire, que sera la parfumerie de demain?*, edited by Louis Labaune, with a preface by Justin Dupont; *La Perfumeria Francesa*, in Italian; *La Parfumerie française aux arts décoratifs; Rétrospective de la parfumerie française;* and *La Parfumerie française à l'exposition coloniale internationale*. These books are all welcome additions to a perfumer's library.

In Germany there appeared *Die Aromata* (Weimar, 1884) by R. Sigismund. It is historical in approach, and contains numerous references to the Greek and Roman writers.

While we do not wish to go into the literature written about or published by the individual firms in the industry, let us make an exception in citing Paul Sentenac's *History of a Perfumer* (Paris, 1925). It is the story of Jean-François Houbigant and the company he founded in 1775. It is at the same time a short and nicely written history of French perfumery from the days of the Bourbons to the Third Republic.

The Popular Literature

Books on the subject of perfumery written for the public have, on the whole, been few in number and inadequate in

treatment. An exception may be made in the case of *This Chemical Age* (New York, 1942) by Williams Haynes, which has one chapter entitled "Sweet Smells and Savory Flavors." These few pages brilliantly summarize an entire industry, sketching its scientific and historical background in but a few words, which become part of a book on the achievements and progress of modern chemistry. We know of no writer in the field of chemistry with a more potent pen, a better feel for a turn of phrase, than Haynes. The literature of perfumery is richer for this chapter of his book.

All too short was H. Stanley Redgrove's *Scent and All about It.* It is good reading and good writing, setting out to explain the origins of perfume raw materials and the art of blending, and should be read by those who are seeking further popular literature on the subject.

One of the earlier writers to devote himself to a popularization of the subject was S. Isermann, who contributed a chapter entitled "Perfumes and Flavors" to *Chemistry and Industry,* Volume 1 (New York, 1924). This is an informative introduction to the subject, though some of its material is no longer up to date.

An unusual piece of work was J. S. Thompson's *The Mystery and Lure of Perfume* (London, 1927). It is an interesting, readable, and popular account of the subject, largely anecdotal, historical, and literary in treatment, and not designed to be scientifically instructive. As such, the author's purpose was achieved, and for popular reading it is recommended.

Finally, among the popular writers one should mention

A. Hyatt Verrill, whose *Perfumes and Spices* (Boston, 1940) devotes about ninety pages to the subject of aroma. A large part of these few pages is given over to the story of ambergris. This book does not explain the science of perfumery, but rather presents its story, and if the information is somewhat sketchy, it is nevertheless a real contribution to the very little reading matter written for popular consumption in this country.

The Perfumer's Reference Shelf

A few volumes have become the standard references of every perfumer. In this literature a unique place is held by *The Volatile Oils*, by E. Gildemeister and F. Hoffmann (three volumes, New York, 1909 to 1922). The first volume contains historical information on essential oils and brief histories of many individual oils. The second and third volumes describe almost a thousand different volatile oils, summarizing such vital information as their botanical origins, methods of production, chemical composition, analytical properties, and in many cases commercial data.

The material is arranged by botanical family, excellently indexed, printed in large and readable type, and despite the wealth of information that scientists have developed since the writing of this book, it remains as indispensable as any that can be named.

The best of the other references are *Perfumes, Cosmetics and Soaps*, by William A. Poucher (three volumes, New York, 1936), *Cyclopedia of Perfumery* by Ernest J. Parry (two volumes, Philadelphia, 1925), and Parry's *The*

Chemistry of Essential Oils and Artificial Perfumes (two volumes, London and New York, 1918–1919).

The Poucher book contains a dictionary of perfume raw materials, natural and synthetic, arranged alphabetically, summarizing the most useful information about the chemistry, odor, origin, and use of several hundred substances.

The second volume consists, in the main, of monographs on natural flower oils and formulas for the blending of perfumes for various purposes. Considerable attention is given in this volume to soap perfumery. The monographs on flower oils differ from those found in other books in that they emphasize information for the perfumer rather than for the chemist. Each monograph is accompanied by formulas by the author for the duplication of the odor of the flower.

The third volume deals almost exclusively with cosmetics and is of secondary interest to the perfumer.

Parry's earlier work contains one volume on essential oils, which brings up to date and restates much of the Gildemeister and Hoffmann material, particularly making use of later information on the chemical composition of the volatile oils and the structure of their component compounds. It is an excellent companion to Gildemeister. In the second volume the author makes a study of the growth and development of the essential oil in the plant, presents an interesting contribution on structure and odor by T. H. Durrans, and gives analytical data on the constituents of essential oils and on synthetic aromatics, methods of analysis, and detection of impurities.

The later book of Parry is thoroughly described in the author's subtitle: "A handbook on the raw materials used by the perfumer, their origin, properties, characters and analysis; and on other subjects of theoretical and scientific interest to the user of perfume materials, and to those who have to examine and value such materials." It, too, is arranged alphabetically, a convenient reference of encyclopedic nature.

The Chemist's Reference Shelf

The chemist dealing with perfumery will find the work of Gildemeister and Hoffmann most valuable, and will have in addition several studies which are indispensable in the preparation of aromatic chemicals. One such work, prepared by F. W. Semmler, is *Die ätherischen Öle* (four volumes, Leipzig, 1906–1907). This is an exhaustive study of the chemical constituents of essential oils, their structure, and the chemistry of the terpenes. It is a landmark in the literature on the subject. Semmler performed a herculean job in gathering, compiling, and assorting the wealth of information found in these volumes.

An outstanding chemist in the field was Otto Wallach, whose *Terpene und Campher* (second edition, Leipzig, 1914) is a standard reference. On the same subject is *The Terpenes*, by J. L. Simonsen (two volumes, Cambridge, 1931–1932), which summarizes the latest findings, particularly on the structure of these compounds, and brings to a conclusion many disputes over structural formulas.

A well-documented and helpful volume is *The Essential*

Oils, by Horace Finnemore (London, 1926). Like Gildemeister, it is encyclopedic in arrangement, designed for reference and not for reading. The oils are taken up by botanical groups, and for each oil there is given data on the botany, agriculture, constituents, chemistry, analysis, and references.

A slim volume that is generally treasured by the chemist working in the field of perfumery is *Die Riechstoffe*, by Georg Cohn (second edition, Brunswick, 1924). Its first section consists of a number of papers dealing with such subjects as the history of perfumery and perfume chemistry, the physiology and psychology of smell, the relationship of odor to constitution. In the latter part of the book there are short descriptions of aromatic chemicals, with literature references, written for the use of the chemist.

Of tremendous value to the chemist is *Die Riechstoffe und ihre Derivate—Die Aldehyde*, by Alfred Wagner (Vienna and Leipzig, 1929), which is a comprehensive study of the chemistry of aldehydes useful in perfumery.

An excellent complement to Gildemeister is found in *Les Parfums naturels*, by Y. R. Naves and G. Mazuyer (Paris, 1939). In their introductory material the authors offer well-documented historical notes on perfumery, the methods of production of natural oils, and the machinery, equipment, and processes employed. The major part of the book consists of short monographs on a large number of oils, particularly those obtained by one of the absorption or solubility processes. The monographs give botanical origin, methods of extraction, physical and chemical characteristics

of the oil, the latest data on the chemical composition, yields, and a separate bibliography for each oil studied.

The Early Formula Books

Formula books, divulging the noblest secrets of the magical art of perfumery, began to appear not long after the first printing presses had been developed. To this day they continue to be written, and become outmoded not many years after they are off the press.

Some of these books are mentioned in bibliographies, and sixteenth-century dates are given. We have failed to locate anything earlier than 1603, when there appeared *I Secreti della Signora Isabella Cortese ne' qualii si contengono case minerali, & medicinali, artificiose, & alchemische, et molte dell'arte profumatoria, appartenti a ogni gran Signora*. The book was published in Venice. It let the reader in on 221 formulas. The only copy we have seen is in the Louis Spencer Levy Collection at the Chemistry Library of Columbia University.

There are a few books that were said to have been published before the work of Signora Cortese. We can touch on them only superficially because we have been unable to locate any copies. One was *Les Secrets de Maistre Alexys le Piedmontois*, which bibliographers place in the early sixteenth century, and another Jean Bodin's *The Decoration of Human Nature and the Adornment of Ladies*, which is said to have been published in Paris, in the French language, in 1530.

In the Rare Book Room of the New York Public Library

there is a little volume published in Venice in 1678. Again, the word "secret" has a prominent place. It is called *Secreti Nobilissimi Dell'Arte Profumatoria*, by Roseto. The volume gives formulas and directions for preparing perfumes, cosmetics, soap perfume compositions, and essential oils. The library copy is still in its original cover.

The French would not let the Italians outdo them in the development of perfume secrets or in divulging the innermost secrets of their art. In 1699 *Le Parfumeur royal* by a perfumer named Barbe was published in Paris. This little book is likewise in its original binding, and is to be found in the New York Public Library. The binder was unable to print the word *Parfumeur* across the cover; so he abbreviated it, *Parfur*. That was all he had room for on one line. The formulas are as quaint, as out-of-date as this method of printing.

In 1699 Barbe was aware of the use of alcohol in perfumery, but was much more interested in perfumes for gloves and tobacco. His main use of alcohol was for "perfume" to be imbibed. He was already using the name that was to become famous, "frangipani," but was not aware of *l'eau admirable*. His book was published with the approval and privilege of the king.

A few years before the publication of *Le Parfumeur royal*, the same author wrote *Le Parfumeur françois*, which disclosed, among other information, "the secret of purifying tobacco and perfuming it with any kind of scent." A copy of this book, also, has not been located by us in America, although writers state that it had a profound influence in

France. The formulas in this book were published, Barbe stated on his title page, for the "entertainment of the nobility, the use of religious persons," and in the hope that the book would prove "indispensable to bathhouse keepers and hair dressers."

An early book on distillation and the production of flower oils was *Traité raisonné de la distillation*, by M. Déjean (Paris, 1753), said to be a pseudonym for Antoine Hornot. It is a big book, of interest to anyone studying the history of distillation or the state of knowledge of perfumery of the period. There are descriptions of methods of distilling the rose, jonquil, and other flowers, and a large number of early perfume formulas.

Another early book on distillation was written by Ambrose Cooper. *The Complete Distiller* (second edition, London, 1760) gave special emphasis to the flowers, drugs, and plants actually used by the perfumer of the time.

In 1774 there appeared in French *Nouvelle chymie du goût et de l'odorat* (two volumes published as one, Paris). The author signed his name only as L'A*** P***, and the foreword refers to a previous edition, dated 1765, a copy of which we have never seen. It would be incorrect to place this with other formula and direction books without citing the valuable historical material on the sense of smell, and the lengthy and learned discussion of whether an odorous material actually loses particles, and therefore loses weight, as it gives off the odor. This subject continued to be debated for a century after the appearance of this book. We have

even discovered in this volume a musical scale of odors, which must have been the inspiration for Piesse's classic work along that line.

L'Art du distillateur d'eaux fortes, by M. Demachy (Paris, 1773), is a direction handbook in methods of preparing essential oils and other materials, with a large number of clear drawings of distillation equipment, apparatus, and explanations of the functioning of this machinery.

The early nineteenth century saw a continuation of the formula books. In *Le Parfumeur impérial*, by C. F. Bertrand (Paris, 1809), the writer is still giving directions for making vinegar waters. Vinegar was considered a necessary part of the toilet, for reasons of health. It was a preservative against contagion and "bad air." By the time Bertrand's book appeared, perfumed gloves were no longer the rage they had been. The Hungary waters were prominent, as were the eaux de Cologne.

Il Credenziere di buon gusto, by Vincenzo Corrado (sixth edition, Naples, 1820), was a formula and direction book, with the emphasis on flavoring materials.

One of the early books to be written in English was entitled *The British Perfumer*, by Charles Lillie. In the second edition, published in London in 1822, the author is described as "the celebrated perfumer standing at the corner of Beaufort Buildings, in the Strand, London, who is spoken of in those admirable works, the 'Spectator, Tatler and Guardian,'" and it is pointed out that the book had been suppressed for about eighty years after it was written,

presumably because Lillie's competitors felt that incalculable harm would be done to them if it saw the light of publication.

Lillie does not seem to have heard about *l'eau admirable*, so popular at the time he was writing. He cites formulas for *l'eau sans pareil*, and describes its tremendous popularity. His perfumes are based, in the main, on a single oil, not on a bouquet. Even his corner on the Strand was not to lose its significance. There it was that the greatest perfume historian of them all, Rimmel, was to open his business.

Nouveau manuel complet du parfumeur, by Mme. Celnart, a pseudonym of Elizabeth F. Bayle-Mouillard, appeared in one edition in Paris in 1845, and in another in 1854. There were formulas for eau de Cologne, vinegar water, and cosmetic materials of all sorts. It was cited by many later writers, and was the basis of an influential American book on the subject. The date of the first edition, which was earlier than 1845, is difficult to trace.

Perfumery: Its Manufacture and Use, by Campbell Morfit (Philadelphia, 1847 and 1853), is primarily of interest because it was one of the first works in America on perfumery. The author borrowed considerably from the French, giving credit to Mme. Celnart. He offered short historical information, and some general remarks on the nature of perfume raw materials, with the bulk of the book consisting of formulas and descriptions for preparing cosmetics.

Another book appearing in America not many years later was Arnold J. Cooley's *Instructions and Cautions*

Respecting the Selection and Use of Perfumes, Cosmetics and Other Toilet Articles (Philadelphia, 1873), which reappeared the next year under the title, *A Complete Practical Treatise on Perfumery.*

On the Eau de Cologne prepared by Farina, Cooley asks, in a footnote: "Which Farina?—for there are now several Farinas at Cologne, each claiming to be the original one, or his descendant." And then Cooley proceeds to give the reader a formula, "confidentially given by the celebrated original Jean Marie Farina, who lived opposite the Jülichs Platz, in Cologne, to a professional gentleman, now deceased, with a solemn assurance that it was the one used by the former in his laboratory. After keeping the secret some years, this gentleman disclosed it." But Cooley made some modifications and improvements of his own, so that the original formula remains undisclosed.

Another American volume of interest issued at about this time was R. S. Cristiani's *A Comprehensive Treatise on Perfumery* (Philadelphia, 1877). It contains historical information, data on essential oils and other perfume materials, and formulas for perfumes and cosmetics.

A French book that attained considerable success was *Nouveau manuel complet du parfumeur* by M. P. Pradal. The date of the first appearance of this book in Paris is not clear. The earliest reference to it that we have found is an American translation by H. Dussauce, published in Philadelphia in 1864, under the title, *A Complete Treatise on Perfumery.* The book appeared in French in a new edition in 1873, and was brought up to date by Malpeyre and

Villon, and elaborated considerably in a two-volume edition appearing in Paris in 1918.

This last edition was intended as a perfumer's general handbook, containing historical information, material on the botany of oil-bearing plants, a study of the origin of the perfume in the flower, material on the classification of odor and on methods of producing oils, monographs on various oils and on synthetics, and formulas for different types of odors. The author of this nineteenth-century manual would surely not have recognized the book published over his name in 1918. But even the 1918 edition was not the final one. As late as 1930, J. Broders again brought Pradal's book up to date and issued a one-volume handbook, continuing to use the original title. Incidentally, despite the duplication of title, the books of Pradal and Mme. Celnart had no connection with each other.

Later Formula Books, Perfumers' Reference Books and Handbooks

The later books for the perfumer were abundant. In addition to formula and direction books, they consisted of reference books and dictionaries, in which lists of essential oils and aromatic chemicals were given, with some information as to their source, use, and odor, as the case might be.

Some of these books were primarily of historical significance. There is Ernest J. Parry's *The Raw Materials of Perfumery—Their Nature, Occurrence and Employment* (London, 1921), which summarizes in a few words the material of his comprehensive references.

Septimus Piesse's *Chimie des parfums et fabrications des essences* (Paris, 1903) is designed to be read by the practicing perfumer. It covers methods of extraction, reviews the essential oils and other perfume raw materials, offers formulations, and contains particularly interesting data on the relationship between odor and color in flowers. It is less important, however, than its author.

One of the first well-written, authoritative works on odors was *Odorographia, A Natural History of Raw Materials and Drugs Used in the Perfumery Industry*, by J. C. Sawer (two volumes, London, 1892). His monographs on the various odors, written before he had any knowledge of synthetics, have since been relegated to the limbo of perfume literature, but were frequently referred to in earlier years, and no doubt profoundly influenced other contemporary writers on the subject.

Two books which became internationally renowned were translated from the German. They were C. Deite's *A Practical Treatise on the Manufacture of Perfumery* (New York, 1892) and George William Askinson's *Perfumes and Their Preparation* (third edition, New York, 1907). The latter book was republished as late as 1924, and was translated into many tongues. On reading today, neither seems to have deserved its auspicious history.

Which, then, are the outstanding formula books? This is a difficult question to answer. One can say that, by and large, few formulas found in any book written before the First World War are of any aid today. Some of the books have an abundance of material, in addition to the

formulas, or instead of the formulas, and deserve special mention.

Of these *Le Livre du parfumeur*, by Félix Cola (Paris, 1934), is unique. This is one of the most imposing of the books on the subject, written by a famous French perfumer. It is a large volume, and makes an effort to be a complete handbook for the perfumer. Its material covers the history of the art, a dictionary of essential oils and aromatics with vital information about each material, and a large number of formulas. It is a book that is interesting reading, original, and revealing the personality of the author on every page. His is a synthesis of the music of words and of perfume. Particularly unusual is his section dealing with the relationship between odor and poetry. Flowers and odors have often been recognized as an inspiration to the poet, but Cola turns the tables and shows poetry as the inspiration to the creator of odors. He quotes lines of French verse suggestive of sweet aromas, and creates, on paper, the perfume inspired by these words. " . . . *Dont le parfum opulent me revient.* . . . " he quotes, and then . . . bergamot 250, vetiverol 60, and on and on, until *le parfum opulent* comes back to him.

Die moderne Parfümerie, by H. Mann (fourth edition by Fred Winter, Vienna, 1932), is a serious, up-to-date and complete formula book, with over 500 pages, with odors of all types for all purposes.

Das Komponieren in der Parfümerie, by Otto Gerhardt (Leipzig, 1931), contains several hundred formulas, material on the psychology of odor, short descriptions of essential oils, aromatics, and specialties, studies on perfume fixation

and on the perfuming of soaps, cosmetics, and creams. In a dictionary of perfume and cosmetic terminology, the English and French equivalents of the German terms are given.

R. M. Gattefossé, one of the best known names in modern French perfumery and a prolific writer, has published several books, outstanding of which is *Formulaire du chimiste-parfumeur et du savonnier* (fourth edition, Paris, 1932). His book covers most perfume raw materials; the art of composing a perfume; and the greater part of it is a study of manufacturing processes and formulas. In the section on the composing of the odor, he gives special attention to the problem of the fixative.

Two books by Fred Winter should be mentioned among the important literature. They are *Handbuch der gesamten Parfümerie und Kosmetik* (Vienna, 1932) and *Riechstoffe und Parfümierungstechnik* (Vienna, 1933). The first of these is just under 1,000 pages, and is one of the most complete handbooks at the disposal of the perfumer. While the larger part of the book consists of formulas and directions, it contains considerable material on essential oils, methods of extraction, and other perfume raw materials, with information of interest both to chemist and perfumer. The second book deals with the chemistry of aromatic substances, the theory and practice of composing a perfume, the technique of manipulation, and also contains formulas.

A reference book for the perfumer is Alfons M. Burger's *Leitfaden der modernen Parfümerie.* It contains the names of perfume raw materials, a brief review of each, and

formulas and hints on the raw materials to be used to obtain a given end effect.

Probably outdated by the recent events in Europe is Arno Müller's *Internationaler Riechstoff-Kodex* (Berlin, 1929). This is a compilation, printed in three languages—French, German, and English. There are lists of aromatic raw materials, with a key number indicating the suppliers in France, United States, Germany, and Switzerland, as well as other countries. The book also contains an arrangement of odorous substances according to the scent and main uses.

Not to be overlooked among the reference books is *Perfumers' Handbook and Catalog*, published by Fritzsche Brothers (New York, 1944). This finely presented volume is crammed full of indispensable information for the perfumer. It covers essential oils, aromatic chemicals, resins, as well as the specialties and compounds of Fritzsche. The larger part of the volume consists of tables, stating the application of the oil or chemical, the physical appearance and color, volatility, solubility in alcohol, and discoloration or stability in milled soaps.

A list of books for the perfumer and the chemist that, in our opinion, seem to be of lesser importance, is presented at the end of this bibliography.

The Horticultural Approach

Every gardener is interested in perfumery, though the gardener's literature on the subject has not been satisfactory. There are a few choice items.

In a sense, the entire literature of gardening is of interest

in the study of perfumery. A comprehensive book on the cultivation of odorous flowers and plants is *The Fragrant Path*, by Louise Beebe Wilder (New York, 1932). Here one will find a discussion of the scents of scores of flowers and of varieties of these flowers. Latin names, botanical data, odor and plant descriptions are given. Sections include night scents, rock garden scented flowers, plants of evil odor, wild scents, and others.

The Book of the Scented Garden, by F. W. Burbridge (London and New York, 1905), is popular, anecdotal, and interesting. It is a horticulturist's approach to perfumery.

Les Parfums et les fleurs, by A. Debay (Paris, 1861), is a serious study, with considerable scientific, commercial, and historical information, dealing with the life of the flower and the relationship between the flower and its scent.

The Scent of Flowers and Leaves—Its Purpose and Relation to Man, by F. A. Hampton (London, 1925), is a contribution to the botanical literature. Unfortunately, a number of chemical errors are found in it: "Ionone is found in violets. . . . Aldehydes become alcohols by oxidation. . . . Vanilla occurs in balsam of Tolu. . . . Little is known about the active principle of animal musk." On the other hand, the volume carries excellent descriptions of the distribution of the oil in plants, the function of scent, the relationship between scent and botanical character, scent and color, and other equally interesting material.

Donald McDonald's *Sweet-scented Flowers and Fragrant Leaves* offers a comprehensive listing of all scented plants, giving botanical name, habitat, and odor descrip-

tion, among other information. It is a "must" for those who would combine the hobbies of gardening and perfumery.

A scientific study of the odor of the rose, the variations in odor from one variety to another, where the oil is found in the rose, and the nature of the oil obtained, is *Les Produits odorants des rosiers*, by R. Blondel (Paris, 1889). A similar study, in English, pamphlet size, is J. C. Sawer's *Rhodologia* (London, 1894).

The Agricultural Approach

Several writers, primarily in France, have written books on the agricultural aspects of essential oil production. One of the best of these is *Les Plantes à parfum et les plantes aromatiques*, by Antoine Rolet (Paris, 1930). The book deals with the types of plants that are valuable for their oils, the geography, the cultural aspects, the ailments that the plants are likely to be afflicted with, fertilization, insect attacks, methods of preparing the oils. These subjects are specifically covered in relation to several plants of outstanding importance to the French perfume industry—jasmin, *rose de mai*, lavender, lavandin, violet, reseda, sage clary, among others. The book is probably invaluable to anyone going into the production of these plants in the United States, where the agricultural information is meager.

Covering somewhat the same ground is Paul Hubert's *Plantes à parfums* (Paris, 1909). The material is not confined to the subject so closely as the work of Rolet, but deals also with the chemistry of perfumes and the methods of extracting the oils.

Le Parfum chez la plante, by Eugène Charabot and C. L. Gatin (Paris, 1908), is a botanical and agricultural study of the life of plants that produce essential oils, studies of the genesis of the oil in the plant, and other botanical and chemical data not readily available or adequately treated elsewhere.

For the International Exposition of Paris in 1900 there was prepared a book entitled *Parfumerie*, by M. L. T. Piver (Paris, 1901). It emphasizes the growth of oil-bearing plants, the countries in which the plants are cultivated, with other historical, commercial, and chemical information.

A book dealing with the soil, growth, insecticidal enemies, irrigation, and harvesting of the perfume plants is Calisto Craveri's *Coltivazione delle Piante Aromatische de Distilleria* (second edition, Milan, 1928).

Offering more statistical information and other industrial agricultural data, but less actual aid to the farmer, is Gustave Faliès's *Les Plantes aromatiques de distillerie* (Paris, 1907).

An unusual and valuable piece of work is *Weltproduktion und Welthandel von ätherischen Ölen*, by H. H. Zander. It is a compilation of statistical data on production of essential oils all over the world. No other single volume offers this summation of vital data.

Odor and Psychology, Philosophy and Medicine

Odor and its relationship to sex, to man's soul and aspirations, and today we would add, to his inhibitions and frustrations, has held the attention of several writers. The scientific approach to this subject is found in Havelock

Ellis's *Studies in the Psychology of Sex* (Volume II, *Sexual Selection in Man*, section entitled "The Sense of Smell"). The work of this author is well known and requires no introduction to our readers, except to call to their attention what he has written on this subject.

Two French authors who have approached this subject are Etienne Tardif, in *Les Odeurs et les parfums, leur influence sur le sens génésique* (Paris, 1899), and Jean Fauconney, writing under the pseudonym of Dr. Caufeynon, in *La Volupté et les parfums* (Paris, 1903). The first of these books is the more scientific, and both are equally provocative. These writers have a peculiar method of spending many pages saying very little.

A curious book, or rather a booklet, is *Philosphie des parfums*, by Charles Regismanset (Paris, 1907). Here are the travels of a mind in its thoughts on perfume. It belongs in the realm of the literature that we call reflections, or as the French like to put it, *pensées*.

L'Ame des parfums by André Monéry (Paris) is more serious than the title might indicate. It is a study of the psychology of odors, and particularly a discussion of the role of smell in French literature, with citations of Flaubert, Zola, Huysmans, Rimbaud, Baudelaire, Verlaine, Maupassant, and many others.

A readable, popular book is *Aromatics and the Soul, A Study of Smells*, by Dan McKenzie (London, 1923). It includes material on smell among insects, olfactory memory, the relationship between smell and the language of odor, smell and the personality. It is replete with anecdotes and

contains excellent summaries of some phases of the scientific literature, such as the work done by Fabre on smell in moths, and Lubbock on ants. There are sections on smell in folklore, religion, and history, an excellent chapter on the theories of olfaction, and a less easily recommended section on language and odor.

The classic in the medical literature was written by Hippolyte Cloquet, *Osphrésiologie ou traité des odeurs, du sens et des organes de l'olfaction* (Paris, 1821). It is cited as authoritative on many phases of the problem to this day.

Les Odeurs du corps humain, by Monin (Paris, 1886), as the name would imply, is a study of the odor of the human body, the causes for the odor, the deviations from the norm.

L'Odorat et ses troubles, by Collet (Paris, 1904), is a medical treatise on the ailments of the nose and the sense of smell, but not considered of great importance.

Sexuelle osphrésiologie, by Hagen (Paris, 1901), is a study of the vagaries of odor fetishists.

A serious psychological study of odor, particularly as related to the sexual life of man, normal and abnormal, is Iwan Bloch's *Odoratus sexualis* (New York, 1934). This book, which is in English, contains excellent bibliographical references.

Of temporary interest in the pharmaceutical literature was a compilation by C. Rohden, *Die Offizinellen ätherischen Öle und Balsame*, which gave the requirements for the various oils and balsams found in the leading pharmacopoeias of the world. It is now outdated.

L'Odorat, by H. Zwaardemaker (Paris, 1925), is a study of the physiology of the sense of smell and of the entire subject of odor intensity and odor measurement. It is a book of first importance. Much of the material in it was also covered in a previous book by the same author, *Die Physiologie des Geruchs* (1895).

Of equal significance is *Der Geruch*, by Hans Henning (Leipzig, 1916), one of the classics in the field. It is a thorough study of the physiology of odor, how we smell, theories of olfaction, olfactory measurements, and classification.

In the English language an excellent work along similar lines is *Smell, Taste, and Allied Senses in the Vertebrates*, by G. H. Parker (Philadelphia, 1922). It covers the physiology of smelling, how we smell, the minimum perceptible odors, and closely related subjects, and is recommended without hesitation. Among its other assets is the bibliographical material appearing in various sections of the book.

Of lesser importance is *Les Odeurs—Demonstrations pratiques avec l'olfactomètre et le pèse-vapeur*, by Charles Henry (Paris, 1892). This was an early effort to study the rate of volatility, the intensity of the odor of essential oils, and related subjects. It has not gained the success of the work of Zwaardemaker, Henning, and others.

The medical literature concerning essential oils and aromatics is not abundant. Two books in French are *Traitement biologique des infections*, by Albert Jentzer (Geneva, 1914), which we have discussed in this book, and R. M. Gattefossé's *Aromathérapie* (Paris). We do not share Gattefossé's enthusiasm for the use of perfume materials

as therapeutic agents, but can state that he has done a serious piece of work, and has compiled a remarkable bibliography on the subject. The book is not dated; from bibliographical references and from book reviews that appeared after publication, we can place it in the middle 1930's.

In several books, particularly those written in England, the problem of the use of essential oils to dissipate the smoke and fog, or aid in overcoming the smell of the sewage, was discussed. In 1661 John Evelyn published *Fumifugium*, in which he suggested planting jasmin, rose, rosemary, and other fragrant flowers in square plots at different spots around the city. In *Nature's Hygiene*, by C. T. Kingzett (third edition, London, 1888), the author devotes a considerable section to the medical and sanitation value of the essential oils, their use as antiseptics and germicides, in connection with the question of sewage and infection.

Odor in the World of Literature

We have already mentioned the work of Monéry in connection with the psychology of odors, and the writings of Ovid in connection with the ancient works on odor. There is hardly a writer of any significance who did not draw on the sweet odors of nature for his inspiration. A few are outstanding.

In the works of Zola odor plays a large part. This has been studied by one of his critics, Leopold Bernard, in *Les Odeurs dans les romans de Zolà* (Paris, 1889). The British poet, Robert Herrick, wrote on the subject considerably, as

did Shakespeare, Baudelaire, Shelley, and Swinburne. In Swinburne, just as there is the conscious effort of the poet to allow the reader to hear the music he is creating with words, so do his word images create smell sensations.

Returning again to the French, there is a chapter on the art of the perfumer in the strange novel by J. K. Huysmans, *Against the Grain* (*A rebours*, Paris, 1884), and in the same author's *Croquets parisiens*, he devotes an entire sketch to a rather unpleasant aspect of odor. *The Picture of Dorian Gray*, by Oscar Wilde, which was largely influenced by *Against the Grain*, likewise contains interesting material on perfumery as seen by the aesthete.

One of the gems of the literature of perfumery is Richard Le Gallienne's *The Romance of Perfume* (New York and Paris, 1928). This little volume is popular, beautifully written, mainly historical and literary in its approach, very romantic, almost mystical.

A curio in the literature on perfumery was written by Benjamin Franklin. It officially bears the title "A Letter to the Royal Academy of Brussels," and while information about it was suppressed for many years by authorities on Franklin, its authenticity is today acknowledged. It was called by Carl Van Doren "the broadest of Franklin's surreptitious pieces," and was described by Franklin himself as "a little jocular paper I wrote some years since in ridicule of a prize question given out by a certain outstanding academy on this side of the water." The letter was printed in *Satires and Bagatelles of Franklin* (Detroit, 1937), and

in a privately printed edition in 1929, which bore the cover title *Dr. Benj. Franklin on Perfumes.*

But there is nothing more curious in the literature of this art than *A Romance of Perfume Lands, or the Search for Captain Jacob Cole, with Interesting Facts about Perfumes and Articles Used in the Toilet,* by Frank S. Clifford (Boston, 1875). This is a novel, as poorly written and as melodramatic as anything we have read since our adolescent days, and yet it has a place of its own on a perfumer's bookshelf. It is the story of the search for a missing captain, and on the Jules Verne-ish trip around the world our heroes stop off at every land where essential-oil-bearing plants are grown, and there the author goes off into a treatise on perfumery and the particular oil—all of which must have been very annoying to the reader in 1875, who wanted to know what had happened to Jacob Cole.

The illustrations bear such titles as, "With one immense leap, he charged up into the air," or "Around us, above us, on every side, stood a tribe of most ferocious looking savages."

Other curios include the detective stories in which the supersleuth solves his crime by a keen sense of smell. One such book is *The Odor of Violets,* by Baynard Kendrick (New York, 1941).

Related Arts—Flavors, Cosmetics, Spices, Soaps

Without making any effort to prepare a comprehensive survey of the literature in the closely related fields, we should

like to mention a few works that merit special attention. *The Chemistry and Manufacture of Cosmetics*, written by M. de Navarre (New York, 1941), is the most up-to-date and indispensable of the cosmetic formulary and direction handbooks. There is very little material on perfumery in this book, however.

A handbook and a guide in the manufacture of soap, modern, up-to-date, industrial, and scientific, is *Modern Soap Making*, by E. G. Thomssen and C. R. Kemp (New York, 1937).

A companion volume to Georg Cohn's *Riechstoffe* is the author's *Die Organischen Geschmackstoffe* (Berlin, 1914). It is a study of the chemistry of flavoring materials, comprehensive and invaluable.

Spices and Condiments, by H. Stanley Redgrove (London, 1933), deals with the raw materials of flavor. It combines in a readable fashion information of botanical, chemical, and industrial interest, containing detailed studies of several of the spices—ginger, angelica root, saffron, dill, pimento, among others.

The latest book on the subject to appear is *Flavor*, by E. C. Crocker (New York, 1945), to whom we have made frequent references in our pages. This book covers the physiology and psychology of the sense of taste, its relationship to odors, the field of natural flavors, the work of tasters; it is not meant as a direction book for those making flavors. Its outstanding interest will be to the trade, and not for popular consumption.

Bibliographical Material

We know of no current bibliography on the subject of odor. In 1922 to 1924, John H. Kenneth published two volumes, under the title *Osmics; the Science of Smell,* (Edinburgh), which listed several hundred important works on the subject, briefly indicating the field covered in each.

J. C. Wiggishoff published a slim volume in Paris, not dated, entitled *Essai de bibliographie des parfums et des cosmétiques*. Its greatest value is no doubt in the numerous early references, particularly those of the sixteenth and seventeenth centuries.

As we have mentioned, several books have good bibliographies on the special subjects treated therein. We particularly recommend for this purpose the works of Parker, Naves and Mazuyer, and Gattefossé's *Aromathérapie*.

Books of Lesser Interest

There are many other books on perfumery, each of which may be of special interest for historical reasons, because of a given formula to be found in it, because of the language in which the book is written, or because of the approach of the author. They seem to us to be of less importance than those described in detail above. We therefore list them below, with a word of description about each.

Askinson, G. W.: *Die Fabrikation der ätherischen Öle* (Vienna, Budapest, Leipzig, 1887). Summarizes production of essential oils, illustrates equipment, offers short monographs on several oils.

ASKINSON, G. W.: *Parfümeriefabrikation* (sixth edition, Vienna and Leipzig, 1911). Studies of essential oils, methods of manufacture, formulas.

CERBELAUD, RENÉ: *Manuel du parfumeur et classification originale des odeurs de même tonalité ou de tonalité voisine* (Paris, 1932). An approach to the art of perfumery through an odor classification system. The author devotes a chapter to a description of the materials of each type of floral odor, such as jasmin, orange, etc. The book contains tables not readily found elsewhere, such as one of aromatics irritating to the skin and

CERBELAUD, RENÉ: *Formulaire des principales spécialités de parfumerie et de pharmacie* (Paris, 1920). A tremendous formula book, devoted more to cosmetics and drugs than to perfumery. The original one-volume edition ran to over 1,500 pages; it was reprinted at a later date in two volumes, which edition contained an interesting short history of perfumes and cosmetics.

CHARABOT, EUGÈNE: *Les Parfums artificiels* (Paris, 1900). One of the early books devoted entirely to synthetic aromatics.

CHARABOT, EUGÈNE: *Les Principes odorants des végétaux* (Paris, 1912). A technical study for the chemist of the odoriferous principles of plants.

CHARABOT, E., J. DUPONT, and L. PILLET: *Les Huiles essentielles et leurs principaux constituants* (Paris,

1899). A large, serious study, treating the oils according to their chief chemical constituents; thus, one class of oils comprises the terpene alcohols and their esters; a subgroup is the linaloöl-containing oils, each of which is then studied separately.

CHIRIS, ÉTABLISSEMENTS ANTOINE: *Contribution to the Knowledge of Essential Oils* (Grasse, 1929). Analytical methods, a discussion of the constituents of essential oils, and analytical data on individual oils.

CLARKE, A.: *Flavoring Materials, Natural and Synthetic* (London, 1922). A flavor reference book.

COLA, FÉLIX: *Dictionnaire de chimie des parfums* (probably Paris, 1927). A dictionary-type reference book, containing names, formulas, solubilities, uses of aromatics derived from essential oils or coal-tar sources.

CRAVERI, CALISTO: *Il Profumiere* (fourth edition, Milan, 1931). A general handbook for the perfumer, including sections on perfume raw materials and formulas.

CRAVERI, CALISTO: *Essenzi naturali* (second edition, Milan, 1927). A technical study of essential oils, with emphasis on the chemistry and botany.

CRAVERI, CALISTO: *Essenzi e profumi artificiali* (second edition, Milan, 1932). The synthesis, odor character, and analysis of some four hundred aromatic chemicals, written for the chemist, and containing some general introductory remarks on synthetic organic chemistry.

CUNIASSE, L.: *Mémorial du parfumeur chimiste* (Paris, 1924). A reference book, dealing in the main with analytical methods, containing standards of essential oils and aromatic chemicals, and a few formulas.

DAVIDSON, J., and K. RIETZ: *Taschenbuch für Parfümerie und Kosmetik* (Stuttgart, 1931). Contains formulas and literature references of aromatic chemicals, tables, names of suppliers, and other information believed to be of interest to the perfumer-chemist.

DEBAY, A.: *Les Parfums de la toilette* (Paris, 1884). A perfume formula and direction handbook.

DEITE, C.: *Manual of Toilet Soap-making* (second edition, London, 1920). Gives considerable attention to perfumery for soap. Monographs on individual essential oils, discussion of synthetic aromatic chemicals, tinctures, extracts, perfume formulas for soap, discoloration, effect of alkali on aromatics, etc.

DELANGE, RAYMOND: *Essences naturelles et parfums* (Paris, 1930). Written for the chemist; contains material on odor and structure; analytical data; essential oils; aromatics, their properties, synthesis, literature references.

DURVELLE, J. P.: *Nouveau formulaire des parfums et des cosmétiques* (fifth edition, Paris, 1930). A volume of about 500 pages, intended to be a complete handbook for the perfumer, although a large part is devoted to cosmetics and soaps. Contains study of perfume raw materials, tables, formulas, directions.

DURVELLE, J. P.: *Fabrication des essences et des parfums* (third edition, Paris, 1930). A technical study, of greatest interest to the chemical engineer engaged in the extraction of essential oils. Also contains monographs on the individual oils, their chemistry, botanical origins.

FERVILLE, L.: *Manuel du coiffeur-parfumeur* (Paris, 1910). A formula book.

FÖLSCH, MAX: *Die Fabrikation und Bearbeitung von ätherischen Ölen* (Vienna and Leipzig, 1930). A technical study of essential oils, their production, chemistry, constituents.

FOUQUET, H.: *La Technique moderne et les formules de la parfumerie* (Paris, 1929). A formula and direction book for the perfumer.

GANSWINDT, A.: *Die Riechstoffe* (Leipzig, 1922). Written to appeal both to chemist and perfumer, this book contains formulas of chemical compounds, historical material on perfumery, sections dealing with volatile oils and aromatics.

GATTEFOSSÉ, R. M.: *Distillation des plantes aromatiques et des parfums* (Paris, 1926). A short technical booklet, with a note on the historical development of distillation and on unusual, exotic apparatus.

GATTEFOSSÉ, R. M.: *Formulary of the Parisian Perfumer* (Paris, 1923). A short formula book, in English.

GATTEFOSSÉ, R. M.: *Nouveaux parfums synthétiques* (second edition, Paris, 1927). A chemist's approach to synthetic aromatic compounds.

GATTEFOSSÉ, R. M.: *Technique de la fabrication des parfums naturels et artificiels* (Paris). A very short technical description of the methods of manufacturing natural perfume materials, together with some data on synthetics.

GAZAN, M. H.: *Flavours and Essences* (London, 1936). A formula handbook.

HASKELL, G.: *Essential Oils and Perfumery* (London, 1926). A compilation of some of the ethereal oils and aromatic chemicals used in perfumery, containing some formulas, and probably intended for the use of druggists and small perfumers.

HEGELBACHER, MARCEL: *La Parfumerie et la savonnerie* (Paris, 1924). A slim volume, covering the highlights of the art, raw materials of natural and synthetic origin, formulas for perfumes and soaps.

HESSE, ALBERT: *Über die Entwickelung der Industrie der ätherischen Öle in den letzten 25 Jahren* (Göttingen, 1909). Primarily written as a tribute to Otto Wallach, the book reviews advances made in the science of essential oils in Germany during the quarter century previous to its publication. There are considerable literature references.

HEUSLER, F.: *The Chemistry of the Terpenes* (Philadelphia, 1902). A summary of the then-known information on terpenes and camphors, their occurrence in nature, synthetic production, derivatives, chemical and physical constants, and literature references. The English translation contains an index and other material not available in the original German.

IDRIS, T. H. W.: *Notes on Essential Oils* (London, 1901). An early reference book, with chemical data, monographs on oils, methods of analysis.

JAUBERT, GEORGE F.: *Matières odorantes artificielles* (Paris). An early summary of synthetic aromatics, with literature references, patents, properties, reactivities.

JAUBERT, GEORGE F.: *Les Parfums comestibles* (Paris). A study of natural oils and synthetics used in flavors. About a third of the book is devoted to vanillin and should interest those making a special study of this subject.

JAUBERT, GEORGE F.: *Produits aromatiques artificiels et naturels* (Paris). Tables of aromatic chemicals, giving nomenclature, formulas, a few words on synthesis, major literature references, and on properties.

JEANCARD, PAUL: *Les Parfums, chimie et industrie* (Paris). A perfumer's reference book, dealing with methods of extraction, analytical techniques, tables. Has an unusual approach to the classification of odorous materials.

KANTHACK, R.: *Tables of Refractive Indices, Volume I, Essential Oils* (London, 1918). A compilation, with numerous references.

KLIMONT, J. M.: *Die synthetischen und isolirten Aromatica* (Leipzig, 1899). An early book on synthetics, for the chemist.

KNOLL, RUDOLF: *Synthetische und isolierte Riechstoffe und deren Darstellung* (Halle, 1908). A short book, for the chemist, on synthetic aromatics and isolates.

LABBÉ, HENRI: *Essais des huiles essentielles* (Paris). An early book on methods of production of essential oils, and monographs on the oils, analyses, falsification, with tables.

LABONNE, HENRY: *Formulaire pratique des parfums et des fards* (second edition, Paris, 1903). An old formulary and dictionary reference book.

LAZENNEC, I.: *Manual de perfumeria* (Barcelona, 1937). A summary of perfume raw materials, and a formula and direction book, for perfumes, soaps, deodorants, hair preparations, and other cosmetic products.

LE FLORENTIN, RENÉ: *Les Parfums* (Paris, 1927). A handbook of perfume raw materials and formulas.

LEIMBACH, ROBERT: *Die ätherischen Öle* (Halle, 1910). Historical data on volatile oils, early methods of distillation, the theory of distillation, formulas of

many constituents, physical and chemical constants, and tables of the oils.

LUNEL, A. B.: *Guide pratique du parfumeur* (Paris). A dictionary reference book, with formulas, definitions, directions.

MAIER, JULIUS: *Die ätherischen Öle* (Stuttgart, 1862). One of the first serious efforts to compile information on the essential oils. Contains a history of production of the oils, particularly distillation, and a discussion of the chemistry of their constituents.

MANN, H.: *Die Schule der modernen Parfümeurs* (Augsburg, 1919). Contains information of interest to those studying perfumery, with crude drawings of apparatus, reference monographs on oils and chemicals, essays on perfume fixation. H. Mann is said to be a pseudonym for Theodor Hofmann.

MARTIN, GEOFFREY: *Perfumes, Essential Oils, and Fruit Essences* (London, 1921). Brief descriptions of perfume raw materials, and formulas for perfumes for handkerchiefs, soaps, sachet powders, etc.

MENDEZ, D. G., and D. J. B. PEREDA: *Nuevo manual del distilador, licorista y perfumista* (Paris and Mexico, 1885). A formula and direction book. The Parisian edition is in Spanish.

MIERZINSKI, STANISLAUS: *Die Fabrikation der ätherischen Öle und Riechstoffe* (Berlin, 1872). An early and seri-

ous book, with sections on methods of preparing the oils, particularly distillation, and summary of the known data, chemical and physical constants of the oils.

MUR, DR.: *Perfumeria y cosmética* (Barcelona, 1933). Deals with perfume and cosmetic formulas; describes some synthetics, natural oils, rectification, methods of production. Contains a chapter on the effect of various metals (copper, aluminum, and others) on essential oils.

NOWAK, CARL A.: *Non-intoxicants* (St. Louis, 1922). A formula book for soft drinks, carbonated beverages, and other flavored drinks, with a title so reminiscent of Prohibition days.

OTTO, M. P.: *L'Industrie des parfums d'après les théories de la chimie moderne* (Paris, 1924). This is an organic chemist's approach to perfumery. The first part of the book is devoted to a general introduction to organic chemistry, elementary, pointing out the functional groups, structural relationships, nomenclature. Includes studies of production of the oils and analytical methods, particularly in the study of sophistication. There is considerable material on the classification of odors.

PERRET, AUGUSTE: *La Parfumerie* (Paris, 1901). A slim technical volume, covering the chemistry and problems of chemical engineering in perfumery. Contains a

dictionary of perfume materials, and a section devoted to soaps and cosmetics.

POPPER, HEINRICH: *Die Fabrikation der nichttrübenden ätherischen Essenzen und Extracte* (Vienna, Budapest, Leipzig, 1889). Methods of production of the oils, studies of flower oils and other products that are used in flavors, and formulas for flavors.

ROCHUSSEN, F.: *Ätherischen Öle und Riechstoffe* (Leipzig, 1909). A chemical study of essential oils and synthetics, with constants and other data.

ROGERS, ALLEN: *Elements of Industrial Chemistry* (New York, 1916). Contains a chapter on perfumery, which was written by one of the pioneers in synthetic aromatics in America, Alois von Isakovics.

ROSSI, ANTONIO: *Manuale del profumiere* (Milan, 1902). A perfumer's handbook, with descriptions of perfume and cosmetic raw materials, equipment and processes for extraction, studies of falsification, and perfume formulas.

SANDÉ, JUAN DE: *El Perfumista moderno* (Barcelona, 1926). A cosmetic and perfume formulation book.

SCHICK, R., and W. ASKINSON: *Die Parfümeriefabrikation* (Vienna and Leipzig, 1935). A short perfume formula and reference book, with methods of producing oils, and an historical note on perfumery.

SIMON, OSKAR: *Laboratoriumsbuch für die Industrie der Riechstoffe* (Halle, 1908). A laboratory guide in essential oils, particularly their analysis.

SNIVELY, JOHN H.: *A Treatise on the Manufacture of Perfumes and Kindred Toilet Articles* (Nashville, 1877). A dictionary of perfumery, and formulas for perfumes, sachets, hair dressings, and other cosmetics.

SORNET, RENÉ: *La Technique industrielle des parfums synthétiques* (Paris, 1923). A brief summary of the chemistry of organic compounds useful in perfumery.

TATU, H.: *L'Industrie moderne des parfums* (Paris, 1932). A professor's book on the chemistry of perfume raw materials, relationship of odor and constitution, with special studies of jasmin, rose oil, lavender, vanillin, and other naturals and synthetics.

VIVAS, S.: *Recetario moderno de perfumeria y cosmética* (Barcelona, 1931). Primarily a formula book and handbook for the perfumer.

VON RECHENBERG, C.: *Theories der Gewinnung und Trennung der ätherischen Öle durch Destillation* (Leipzig, 1910). An exhaustive chemical study of the theory and practice of distillation, particularly when applied to the field of essential oils.

VON RECHENBERG, C.: *Einfache und Fraktionierte Destillation in Theorie und Praxis* (Leipzig, 1923). A study of distillation, along the line of Von Rechenberg's

earlier book, with less specific emphasis on the essential oils.

WAGNER, ALFRED: *Aromastoffe* (Dresden and Leipzig, 1933). A reference book of aromatic substances, with alternative names, formulas, constants, uses, and a large section on flavoring essences.

WAGNER, ALFRED: *Die Parfümerieindustrie* (Halle, 1928). A reference book for the perfumer. Contains material on the mechanism of olfaction, the chemistry of smell, laboratory equipment, perfume raw materials, the making of a perfume, and formulas and directions.

WAGNER, ALFRED: *Die ätherischen Öle* (Leipzig, 1925). Essential oils, their methods of production, analysis, with short monographs on individual oils, botanical and geographical origins, constants, methods of production, analytical methods to be employed, etc.

WALTER, ERICH: *Manual for the Essence Industry* (New York, 1916). A formula and laboratory book, a practical guide for those engaged in the flavoring industry.

WULFF, GUNKO, *et al.*: *Essential Oil Plants, Their Cultivation and Essential Oils* (Leningrad, 1934). This is a large, serious work, a study of the entire field of essential oils, covering material somewhat along the line of Gildemeister, but with more emphasis on the possibilities of Russian cultivation and Russian use. Few copies of the book are available in this country, and

our comments are based on a section privately translated for us in 1942.

ZAMARIN, GUID: *Tested Formulary for Perfumes, Cosmetics, Soaps, Liquors, Wines and Syrups* (Mexico City, 1937). A formula, dictionary, and direction book, covering a wide variety of subjects in addition to perfumes. Editions of this book were published in English and in Spanish, and it is said to be popular in the trade in Mexico.

Periodical Articles and Pamphlets

Many of the most significant pieces of writing on perfumery have appeared in articles in periodicals or have been issued as pamphlets. It would be impossible at this time to review such articles, or even to list them, because their number is legion.

Instead, we shall confine ourselves to those pamphlets and periodical articles which have most aided us or to which we have referred in some of the chapters in the course of this book.

CHAPTER 3

GUENTHER, ERNEST: The peregrinations of Ernest Guenther have made him America's most prolific writer and outstanding authority on essential oils. He has written over a hundred articles on individual essential oils; though not yet collected in book form, they are invaluable reference sources.

HAAGEN-SMIT, A. J.: "The Chemistry of Essential Oils," *Chemurgic Digest*, June 30 and July 15, 1944.

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GUENTHER, ERNEST: "Natural Flower Oils," *American Perfumer*, February, April, August, October, November, 1934.

PASSY, JACQUES: "Sur un nouveau mode d'obtention du parfum des fleurs," *Comptes rendus hebdomadaires des séances de l'académie des sciences*, Vol. 121, p. 783, 1897.

SIEVERS, A. F.: "Methods of Extracting Volatile Oils from Plant Material and the Production of Such Oils in the United States," *U.S. Department of Agriculture, Technical Bulletin* 16, January, 1928.

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ANONYMOUS: "American Musk from Muskrats," *American Perfumer* and *The Givaudanian*, December, 1943.

CRISTIANI, R. S.: "American Musk," *The Soap Makers' Journal*, April, 1882.

ERICKSON, J. L. E.: Personal Communication, November, 1944.

STEVENS, P. G.: Personal Communication, November, 1944.

STEVENS, P. G.: "Perfume Fixatives—The Chemistry of Scents," *The Yale Scientific Magazine*, March, 1945.

STEVENS, P. G., and J. L. E. ERICKSON: "American Musk. I. The Chemical Constitution of the Musk of the

Louisiana Muskrat," *Journal of the American Chemical Society*, Vol. 64, p. 144, 1942.

CHAPTER 7

RUZICKA, L., and V. FORNASIR: "Über die Totalsynthese des Linaloöls," *Helvetica Chimica Acta*, p. 182, 1919.

CHAPTER 8

PENFOLD, A. R.: "The Chemistry of Concrete Otto of Boronia megastigma (Nees)," *Journal Royal Society of Western Australia*, Vol. 14, p. 2, 1927.

SABETAY, S.: "Sur la présence de la β-ionone dans un produit naturel," *Comptes rendus hebdomadaires des séances de l'académie des sciences*, Vol. 189, p. 808, 1929.

CHAPTER 10

KUNZ, ERIC C.: "Prices of Perfume Bases Cannot Be Maintained," *The Givaudanian*, August, 1941.

SAGARIN, EDWARD: "The Strange Odyssey of Ten Tons of Oakmoss," *Drug and Cosmetic Industry*, February, 1943.

CHAPTER 12

BOGERT, MARSTON T.: *Synthetic Organic Chemistry in the Study of Odorous Compounds*, New York, 1927.

CROCKER, E. C. and L. F. HENDERSON: "Analysis and Classification of Odors," *American Perfumer & Essential Oil Review*, August, 1927.

ELSBERG, C. A. *et al.*: "The Sense of Smell," *Bulletin of the Neurological Institute of New York*, 1935–1937.

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APPENDIX B

A Note on Orthography

An accepted and standardized orthography of the technical terms frequently used in any science or industry is desirable. Many of the words used in this book are spelled in different ways in industrial catalogues, in the trade press, and in scientific literature. This note is written as an explanation of the forms of spelling we have chosen and as a contribution toward the clarification of this situation.

We have preferred, in this book, the spelling *jasmin* rather than *jasmine*. The former corresponds more closely to the French and Spanish *jasmin*, and to the Persian and Arabic *yasmin*. Furthermore, the word is pronounced with a short *i*, and the accent falls on the first syllable. A final silent *e* in English usually makes the preceding vowel a long one. The spelling we have chosen is not used by *Chemical Abstracts* but is preferred by *Perfumery and Essential Oil Record*.

The orthography of *patchouli* is more difficult to justify. Other versions of the word are *patchouly* and less frequently *pachouli* and *pachouly*. The spelling we have chosen is used by *Chemical Abstracts* and by most publications in the field.

There are several versions of *vetivert*, including *vetiver*,

vetyver, and very rarely *vetyvert*. The dictionary also gives the spelling *vetiveria*, which we have never seen used. The word comes from the ancient Asiatic language, the Tamil, where it was written *vettiver*. The version we have used, *vetivert*, is preferred by *The American Perfumer*, while *vetiver* is used by *Chemical Abstracts*.

Several terms can be alternately written as one word or two or as a hyphenated word. They include *lemongrass*, *gingergrass*, *cedarwood*, *oakmoss*, and *petitgrain*, for which we prefer the one-word version, and *orris root*, which we maintain should be written as two words.

Varieties in the orthography of *ylang ylang* include the replacement of each *y* by an *i*; on rare occasions the replacement of each *y* by *ih*; and hyphenated versions like *ylang-ylang* or *ilang-ilang*. There is also a corrupt version that consists of dropping the second part of the phrase and referring to the plant or oil as *ylang*.

Gum *benzoin* has been called *benjamin*, another version of the same word. The former spelling is more widely accepted and is preferable from a chemical and historical point of view.

The spice *cardamom* from which an essential oil is obtained, is frequently written as *cardamon* and rarely as *cardamum*. The first version we have mentioned should be used, in our opinion, as it is justified by the Latin *cardamomum* and the botanical term *Amomum*.

The essential oil, *camomile*, is frequently called *chamomile*. Dictionaries seem to prefer the former and essential-oil publications the latter.

Another spice, *pimento*, from which an oil is obtained, is also written as *pimiento* and *pimenta.*

Several words that have been assimilated into the English language are alternately written with or without their foreign accents. For instance, one can write *néroli* or *neroli.*

There are oils for whose names English equivalents are known though the foreign word is still widely used. Thus one finds *bois de rose* and *rosewood* used almost interchangeably. The French word *badiane* is still met in place of *star anise.*

Opopanax is spelled in some journals *opoponax* but there seems little justification for the latter version. *Bigarade* is occasionally spelled without the second *a*, a version we should not like to see accepted.

There are two spellings, *linaloe* and *linaloa*, for the plant of that name. The former is more widely used in the industry.

Versions of *labdanum* include *ladanum* and *laudanum*, the first being most frequently used in perfumery publications.

There is, in the United States, an accepted authority on the spelling of chemical nomenclature. This is the journal *Chemical Abstracts* whose spellings for chemical names we have used, even when they did not conform to the version most frequently accepted in the industry.

The word *linaloöl* is also written as *linalol* and *linalool.* The double *o* is justified because the *ol* suffix denotes an alcohol, and the first *o* is derived from the name of the

plant in which the alcohol was found. There is a tendency to drop the diaeresis over the second *o*.

We have used the spellings *indole*, *skatole*, *anethole*, and *safrole* although perfumery publications prefer to spell all these words without the final *e*. The *ol* suffix is today reserved exclusively for alcohols and phenols; organic chemicals that do not fall into those groups and that were formerly spelled with an *ol* ending have had this termination changed to *ole*. (The versions *scatol* and *scatole* are sometimes used but are not acceptable.)

In the same way, we have preferred the spelling *heliotropin* to *heliotropine* in accordance with the official rule of chemical nomenclature, which states that "the ending *ine* is reserved exclusively for nitrogenous bases."

We hope that in the years to come there will be a greater degree of standardization in the spelling of perfume terminology.

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